Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310

CONTRACT NO. N62473-06-D-2201
CTO NO. 0006

FINAL

RADIOLOGICAL ADDENDUM TO THE REVISED FEASIBILITY STUDY FOR PARCEL D

April 11, 2008

DCN: ECSD-2201-0006-0078

PARCEL D, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

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DCN: ECSD-2201-0006-0078

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EXECUTIVE SUMMARY

The Department of Navy has prepared this Radiological Addendum to the Revised Feasibility Study for Parcel D, Volume II to address potential radioactive contamination in buildings, former building sites, groundwater, outdoor areas, storm drains, and sanitary sewers in Parcel D at Hunters Point Shipyard, a deactivated Department of the Navy shipyard on San Francisco Bay in southeastern San Francisco, California. This addendum provides information to support the future Proposed Plan to update the remedial alternatives along with a reevaluation of remedial alternatives that address soil, sites, and structures that pose a radiological risk.

The primary purpose of this addendum is to provide decision makers with the information necessary to select a final remedy for radiologically-impacted buildings (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819), former building sites (313, 313A, 317, 322, and 383 area), outdoor areas (Gun Mole Pier and Naval Radiological Defense Laboratory Site on Mahan Street), and soils and piping associated with remediated storm drains and sanitary sewers. This is accomplished through the development and evaluation of appropriate remedial alternatives. The alternatives presented in this document are similar to those in scope identified in the Revised Feasibility Study for Parcel D (SulTech, 2007). In addition, alternatives are chosen for Parcel D radiologically-impacted sites. The following general steps were used to achieve this purpose:

1. Development of a conceptual site model that summarizes the Hunters Point Shipyard and Parcel D background, nature of the contaminant release, environmental media impacted, fate and transport of radionuclides of concern in the environment, potential receptors and exposure pathways, and a risk assessment.
2. Development of remedial action objectives for radioactively contaminated media.
3. Development of general response actions (e.g., remediation, excavation, or containment) that may be taken to satisfy the remedial action objectives. The general response actions are similar in scope as those established in the Revised Feasibility Study for Parcel D (SulTech, 2007) along with additional general response actions for radiologically-impacted buildings.
4. Identification of radiologically-impacted buildings and sites where general response actions will be applied.
5. Identification and evaluation of technology options applicable to each general response action based on their ability to achieve the remedial action objectives, technical and administrative implementability, and cost.
6. Delineation of selected representative technologies and process options as they correspond to different general response actions to develop a range of remedial alternatives.

7. Performance of detailed analysis of remedial alternatives based on seven of the nine evaluation criteria in the National Oil and Hazardous Substances Pollution and Contingency Plan (40 Code of Federal Regulation, Section 300.430 [e][9][iii]).
8. Performance of comparative analysis of alternatives for each of the evaluation criteria to identify the relative advantages and disadvantages of each alternative.

Hunters Point Shipyard is a former Department of the Navy shipyard located in the southeast portion of the City of San Francisco, California, situated on a long promontory extending eastward into the San Francisco Bay. The Hunters Point Shipyard property currently consists of approximately 866 acres, about 446 of which are offshore.

The shipyard is divided into six parcels: B, C, D, E, E-2, and F. Originally the shipyard property included Parcel A that was transferred to the San Francisco Redevelopment Agency in December 2004, and is no longer Department of the Navy property. This radiological addendum focuses on Parcel D only.

Parcel D is located in the southeast-central quadrant of Hunters Point Shipyard. It has multiple buildings (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819), outdoor areas (Gun Mole Pier and the Naval Radiological Defense Laboratory site on Mahan Street), former building sites (313, 313A, 317, 322, and 383 area), storm drains, and sanitary sewers that are considered radiologically-impacted. Radiological operations within these areas included decontamination training; Naval Radiological Defense Laboratory instrumentation laboratory, stockroom, storage, temporary animal quarters, Thermal Branch, Engineering Division, sampling laboratory, general research laboratories, biological research laboratories, optical laboratories, and field office personnel decontamination, radioactive waste storage, radiography source operations, storage of samples from atomic weapons testing, and maintenance and storage of radioluminescent devices. One outdoor area (the Naval Radiological Defense Laboratory Site on Mahan Street) was potentially used as a storage site of OPERATION CROSSROADS material (Naval Sea Systems Command, 2004). The table below shows the various Parcel D radiologically-impacted structures, former building sites, and outdoor areas along with their redevelopment block number, planned reuses, and reuse scenario.

Building/Site Number	Redevelopment Block	Redevelopment Block Planned Reuse	Reuse Scenario
274	DMI-1	Maritime-Industrial	Industrial
313 Site	DMI-1	Maritime-Industrial	Industrial
313A Site	DMI-1	Maritime-Industrial	Industrial
317 Site	39	Open Space	Recreational
322 Site	DMI-1	Open Space	Recreational
351	39	Open Space	Recreational
351A	39	Open Space	Recreational
364	39	Open Space	Recreational
365	39	Open Space	Recreational
366/351B	39	Open Space	Recreational
383 Area	DMI-1	Maritime-Industrial	Industrial
401	30A	Mixed Use	Residential
408	38	Industrial	Industrial
411	38	Industrial	Industrial
813*	A	Research and Development	Residential
819*	A	Research and Development	Residential
Gun Mole Pier	DMI-1	Maritime-Industrial	Industrial
Naval Radiological Defense Laboratory Site on Mahan Street	DMI-1	Maritime-Industrial	Industrial
Sanitary Sewers	All Blocks	Industrial, Maritime-Industrial, Mixed Use, and Research and Development	Residential
Storm Drains	All Blocks	Industrial, Maritime-Industrial, Mixed Use, and Research and Development	Residential

Notes:

* Buildings 813 and 819 have been surveyed for release from radiological control pending regulatory approval.

Most of Parcel D is located in the lowlands, with surface elevations between zero to 10 feet above mean sea level (SulTech, 2007). No threatened or endangered species are known to inhabit Parcel D. The ecology at Parcel D is limited to plant and animal species adapted to an industrial environment. Viable terrestrial habitat is inhibited at Parcel D because about 85 percent of the ground surface is covered by pavement and buildings (SulTech, 2007).

The radionuclides of concern associated with Parcel D include cesium-137, cobalt-60, plutonium-239, radium-226, strontium-90, thorium-232, tritium (H-3), uranium-235, and naturally occurring radioactive materials found in firebricks. Radioluminescent devices were commonly used on all types of Navy ships through the late 1960s. The radionuclides associated with radioluminescent devices used on ships are radium-226 and strontium-90. In addition to being used as a Department of the Navy shipyard, Hunters Point Shipyard was home to the Naval Radiological Defense Laboratory whose mission was to study the effects of atomic weapons. Numerous ships that participated in atomic weapons testing from 1946 through the early 1960s were returned to Hunters Point Shipyard for decontamination. The majority of these ships participated in the two original atomic weapons tests during OPERATION CROSSROADS. Ship berths (piers) are known locations of decontamination operations and residues from these operations were potentially disposed of at the shipyard or discharged into the sanitary and storm drain system. Building 365 was used as a decontamination center for personnel working in Building 364 and participating in the hot barge work. The radionuclides associated with the decontamination activities are plutonium-239, cesium-137, and strontium-90.

The remedial action objectives for radionuclides of concern in Parcel D were developed based on the medium of concern, potential exposure pathways, and applicable or relevant and appropriate requirements. The following radiological remedial action objectives were identified for buildings 274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819; soils of former building sites 313, 313A, 317, 322, and 383 area; outdoor areas Gun Mole Pier and Naval Radiological Defense Laboratory site on Mahan Street; and soils and piping associated with remediated storm drains and sanitary sewers of Parcel D:

- Reduce exposure to incremental concentrations of the radionuclides of concern above naturally occurring levels such that an estimated lifetime cancer risk (above background) does not exceed the risk range 10^{-6} to 10^{-4}.
- Reduce exposure in soil from radionuclides of concern exceeding the site-specific cleanup goal (remediation goals).

The following alternatives were identified in the Revised Feasibility Study for Parcel D and modified to satisfy the remedial action objectives listed above. The alternatives are grouped S for soil, GW for groundwater, and R for radiologically-impacted sites.

- <u>Alternative S-1: No Action</u>: For this alternative, no remedial action would be taken. The no-action response is retained through the evaluation process as required by the National Oil and Hazardous Substances Pollution Contingency Plan to provide a baseline for comparison with other alternatives.
- <u>Alternative S-2: Institutional Controls and Maintained Landscaping</u>: Alternative S-2 consists of institutional controls and maintained landscaping that together will meet all applicable or relevant and appropriate requirements and remedial action objectives. The institutional controls include access restrictions and covenants to

restrict use of property that will be implemented parcel-wide for all of the redevelopment blocks. The maintained landscaping would prevent potential exposure to asbestos (that may be present in surface soil and transported by wind erosion) that would not be addressed by institutional controls alone.

- Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls: Alternative S-3 consists of soil excavation and off-site disposal (including radionuclides of concern), maintained landscaping, and institutional controls similar to those of Alternative S-2. In areas where lead and polyaromatic nuclear hydrocarbons are constituents of concern, soil above remediation goals will be excavated and disposed of at an off-site facility. This alternative will provide a more permanent remedy to reduce the volume and toxicity of contaminants where excavation is feasible, as described in the Revised Feasibility Study for Parcel D (SulTech, 2007). Areas of bare or minimally vegetated soil that have been disturbed by excavation or construction activities and not restored with a cover will be covered by maintained landscaping as described in Alternative S-2.

- Alternative S-4: Covers and Institutional Controls: Alternative S-4 consists of covers to remove the exposure pathway to soil contaminants and institutional controls similar to Alternatives S-2 and S-3. Covers included in this alternative may include new covers and existing or future building footprints, roads, parking lots, and maintained landscaping. Institutional controls are included in this alternative for both short-term and long-term mitigation of risk exposure. In addition to institutional controls similar to those required for Alternative S-2, institutional controls will also be included that would require maintenance of covers.

- Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls: Alternative S-5 consists of a combination of soil excavation, disposal, covers, and institutional controls. This alternative was developed as a combined alternative to 1) remove and dispose of lead and polyaromatic nuclear hydrocarbons as described in Alternative S-3, 2) implement and maintain block-wide covers as described in Alternative S-4, and 3) implement parcel-wide institutional controls as described in Alternative S-2.

- Alternative GW-1: No Action: For this alternative, no remedial action will be taken for groundwater. Groundwater conditions will be left as is, without implementing any response actions. The no-action response is retained throughout the evaluation process as required by the National Oil and Hazardous Substances Pollution Contingency Plan to provide a baseline for comparison with other alternatives.

- Alternative GW-2: Long-Term Groundwater Monitoring and Institutional Controls: Alternative GW-2 consists of groundwater monitoring and institutional controls. This alternative was developed as a method for monitoring contaminants present at low concentrations in groundwater. Additionally, groundwater monitoring would be used to confirm site conditions and ensure that, over time, the potential exposure pathways remain incomplete. Institutional controls are also included in this alternative to effectively manage risk by preventing exposure and use of the groundwater. Groundwater monitoring for the radionuclides of concern would be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.

- Alternatives GW-3A and GW-3B: In-Situ Treatment for Volatile Organic Compounds, Groundwater Monitoring for Metals and Volatile Organic Compounds, and Institutional Controls: Alternatives GW-3A and GW-3B consist of in situ treatment of the VOC contaminant plumes. GW-3A and GW-3B do not treat metals in groundwater. These alternatives also include groundwater monitoring for metals and volatile organic compounds and institutional controls similar to those described for Alternative GW-2. Alternatives GW-3A and GW-3B involve using different in situ treatment reagents (a biological substrate for 3A and zero-valent iron for 3B), to treat volatile organic compounds. Because Alternatives GW-3A and GW-3B do not treat metal constituents of concern, metals would be monitored under this alternative. Alternatives GW-3A and GW3B are intended to reduce the required time to meet the groundwater Remedial Action Objectives, and as a result, the length of groundwater monitoring and possibly the time required for the institutional controls. The institutional controls in Alternatives GW-3A and GW-3B would be the same as the institutional controls in Alternative GW-2.
- Alternatives GW-4A and GW-4B: In-Situ Treatment for Volatile Organic Compounds and Metals, Groundwater Monitoring, and Institutional Controls: Alternatives GW-4A and GW-4B consist of in-situ treatment of the contaminant plumes for both volatile organic compounds and metals in addition to groundwater monitoring and institutional controls similar to Alternative GW-2. Alternatives GW-4A and GW-4B involve using different in-situ treatment reagents. Alternative GW-4A would use a slow-release substrate designed to promote anaerobic bioremediation to degrade chlorinated chemicals of concern to nontoxic compounds. Alternative GW-4B would use a metal-organo-sulfur compound to treat for metals. These alternatives were selected to reduce the required time to meet the groundwater remedial action objectives, and as a result, the length of groundwater monitoring and possibly the time required for institutional controls. Groundwater monitoring for the radionuclides of concern would be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.
- Alternative R-1: No Action: No remedial action would be taken for radiologically-impacted sites. The no-action response is retained through the evaluation process as required by the National Oil and Hazardous Substances Pollution Contingency Plan to provide a baseline for comparison with other alternatives.

Alternative R-2: Survey, Decontamination, Excavation, Disposal, and Release: Alternative R-2 consists of survey of buildings, soils of former building sites, trenches resulting from sewer and storm line removal, soils of remediated storm drains and sanitary sewers to meet the remedial action objectives, and soils of outdoor areas Gun Mole Pier and the NRDL Site on Mahan Street; decontamination of radiologically-impacted buildings and dismantlement if necessary (if remedial actions are not successful or if remedial actions affect the stability of the structure); excavation of soils of former building sites, trenches resulting from sewer and storm line removal, soils of remediated storm drains and sanitary sewers, and soils of outdoor areas Gun

Mole Pier and the NRDL Site on Mahan Street to meet the remedial action objectives. Excavation would continue until results of confirmation samples indicate that RAOs are met.

Each remedial alternative developed in the Revised Feasibility Study for Parcel D and this addendum was evaluated in comparison to the two threshold and five balancing National Oil and Hazardous Substances Pollution Contingency Plan evaluation criteria. Comparison to the two modifying criteria of regulatory and community acceptance will be included in the final Revised Feasibility Study for Parcel D report, this addendum, and future proposed plans after comments are received. Further discussion of these criteria is not included in this report. A comparative analysis was then conducted to evaluate the relative performance of the five soil, three groundwater, and three radiologically-impacted site remedial alternatives developed for Parcel D.

An overall rating was assigned to each alternative. Alternatives S-2 through S-5 each meet the threshold criteria. Alternative S-5 is rated excellent overall for the five balancing National Oil and Hazardous Substances Pollution Contingency Plan evaluation criteria. Alternative S-5 is the most effective, with both excavation and covers, although it has an additional cost ($0.1 million) associated with the radiological support required. Alternative S-3, rated good, is more effective than Alternative S-2 because contaminants are removed, although it is more expensive at an additional cost ($0.1 million). Alternative S-4, rated good, is not more effective than Alternatives S-3 or S-5 and is similar in cost to Alternative S-2. Alternative S-2, rated good, is easiest to implement and does not have additional costs associated with it. Alternative S-1 is rated as not acceptable.

Alternatives GW-4A and GW-4B, rated excellent, have the highest overall rating. The treatment in Alternatives GW-4A and GW-4B effectively reduces risks to human health and environment and has a moderate additional cost of ($0.35 million). Alternatives GW-3A and GW-3B are rated very good, but do not treat for metals and still have an additional cost ($0.18 million). Alternative GW-2, rated good, is easy to implement and has an additional cost ($0.61 million), but it is not as effective as Alternatives GW-3A, GW-3B, GW-4A or GW-4B. Alternative GW-1 is rated as not acceptable.

Alterative R-2, rated very good, has an estimated cost of $30.5 million and removes all radionuclides of concern. Alternative R-1 is rated as not acceptable.

Figure ES-1 summarizes the results of the evaluation.

DRAFT FINAL
REVISED FEASIBILITY STUDY FOR PARCEL D

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ABBREVIATIONS AND ACRONYMS

§	section
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ARIC	Area Requiring Institutional Controls
BRAC PMO	Base Realignment and Closure Program Management Office West
^{14}C	carbon-14
C.C.R.	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDPH	California Department of Public Health
C.F.R.	Code of Federal Regulations
cm^2	square centimeter
^{60}Co	cobalt-60
COC	constituent of concern
^{137}Cs	cesium-137
DoD	Department of Defense
DON	Department of Navy
dpm	disintegration per minute
DTSC	Department of Toxic Substances Control
EFA West	Engineering Field Activity West, Naval Facilities Engineering Command
ELCR	excess lifetime carcinogenic risk
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	Feasibility Study
GRA	general response action
^{3}H	hydrogen-3 (tritium)
HPS	Hunters Point Shipyard
HRA	Historical Radiological Assessment
IC	institutional control
LFE	LFE Environmental Analysis Laboratories, Inc.
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

ABBREVIATIONS AND ACRONYMS
(Continued)

MCL	Maximum Contaminant Level
mrem/y	millirem per year
msl	mean sea level
NAVFAC SW	Naval Facilities Engineering Command, Southwest
NAVSEA	Naval Sea Systems Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NRDL	Naval Radiological Defense Laboratory
O&M	operation and maintenance
PAH	polyaromatic nuclear hydrocarbons
pCi/g	picocurie per gram
pt	part
^{239}Pu	plutonium-239
^{226}Ra	radium-226
^{228}Ra	radium-228
RADLAB	Radiation Laboratory
RAO	Remedial Action Objective
RASO	Radiological Affairs Support Office
RESRAD	Residual Radioactivity (Model)
RESRAD-BUILD	Residual Radioactivity-Building (Model)
RG	Remediation Goal
RMP	Risk Management Plan
ROC	radionuclide of concern
ROD	Record of Decision
RSS	Radiological Safety Section
SFRA	San Francisco Redevelopment Agency
^{90}Sr	strontium-90
TCRA	time-critical removal action
^{232}Th	thorium-232
tit.	title
^{235}U	uranium-235
VOC	volatile organic compound

1.0 INTRODUCTION

This document provides a radiological addendum to the Revised Feasibility Study (FS) for Parcel D (SulTech, 2007) at Hunters Point Shipyard (HPS), San Francisco, California. The addendum was developed under Remedial Action Contract No. N62473-06-D-2201, Contract Task Order No. 0003 for the Department of the Navy (DON), represented by the Base Realignment and Closure Program Management Office West (BRAC PMO), Naval Facilities Engineering Command, Southwest (NAVFAC SW), and the Radiological Affairs Support Office (RASO). This addendum complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

1.1 PURPOSE

This addendum presents alternatives for radiologically-impacted sites that include remediation of or remedies for radionuclides of concern (ROCs), which are cesium-137 (^{137}Cs), cobalt-60 (^{60}Co), hydrogen-3 (^{3}H), plutonium-239 (^{239}Pu), radium-226 (^{226}Ra), thorium-232 (^{232}Th), uranium-235 (^{235}U), and strontium-90 (^{90}Sr). Radiologically-impacted sites include buildings (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819); former building sites (313, 313A, 317, 322, and 383 area); outdoor areas (Gun Mole Pier and the Naval Radiological Defense Laboratory [NRDL] site); and soils and piping associated with remediation of storm drains and sanitary sewers (Naval Sea Systems Command [NAVSEA], 2004) as identified in Figure 1-1. This addendum excludes ship berths in Parcel D. These have been moved into Parcel F. The following guidelines were used for preparation of this addendum:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA; Interim Final* – U.S. Environmental Protection Agency (EPA) Guidance (EPA 540-G-89-004) (EPA, 1988).
- *Technology Screening Guide for Radioactively Contaminated Sites* – EPA Guidance (EPA 402-R-96-017) (EPA, 1996).
- The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 of the Code of Federal Regulations [C.F.R.], Part 300.430 [40 C.F.R., Part 300]).
- *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, Attachment A, USEPA, OSWER Directive 9200.4-18 (EPA, 1997).

The radiological cleanup alternatives (surveys and remediation) proposed in this document will be performed and coordinated in conjunction with the chemical CERCLA work proposed in the Revised FS for Parcel D. This addendum helps to ensure that worker, public, and environmental exposure to radioactivity is as low as reasonably achievable (ALARA) and evaluates the combined chemical and radiological risk.

1.2 ORGANIZATION OF ADDENDUM

This report has been organized into the following sections:

- **Section 1.0: Introduction** – This section presents the purpose of the addendum, guidance documents used for its preparation, and organization of the report.
- **Section 2.0: Parcel D Site History and Characterization** – This section presents the site background, potential sources and mechanisms for release of the radionuclides, environmental media impacted, fate and transport of the radionuclides in the environment, potential receptors, and exposure pathways.
- **Section 3.0: Risk Evaluation Summary and Remediation Goals** – This section presents a summary of the radiological risk to human health based on the conditions in soil, the planned future land and building uses, and remediation goals for the ROCs (DON, 2006). The combined chemical and radiological risk is also presented in this section.
- **Section 4.0: Remedial Action Objectives, General Response Actions, and Process Options** – This section discusses remedial action objectives (RAOs), including identification of applicable or relevant and appropriate requirements (ARARs), and identification and screening of potential general response actions (GRAs) to satisfy the RAOs.
- **Section 5.0: Development and Description of Remedial Alternatives** – This section presents a detailed description of the remedial alternatives based on the process options selected in Section 4.0 that will satisfy the RAOs. Process options recommended for consideration are assembled, singularly or in combination, to create remedial alternatives.
- **Section 6.0: Detailed Analysis of Alternatives** – This section presents a detailed evaluation of alternatives with respect to the evaluation criteria specified in the NCP (40 C.F.R., Part 300.430[e][9][iii]) to address statutory requirements and preferences of the CERCLA.
- **Section 7.0: References** – This section includes references used to prepare this document.
- **Tables and figures are included following the text.**
- **Appendix A**: Parcel D Risk Screening Analysis presents detailed discussion of the risks associated with implementation of the various alternatives for residual radioactivity.
- **Appendix B**: Remedial Action Alternative Cost Summary Sheets presents detailed costs and associated assumptions for each alternative.
- **Appendix C**: ARARs identify and evaluate potential federal and State of California ARARs applicability to the alternatives.

2.0 PARCEL D SITE HISTORY AND CHARACTERIZATION

This section summarizes the site background, potential sources of radiological contamination, nature of release, environmental media impacted, fate and transport of ROCs potentially present at Parcel D, potential receptors, and exposure pathways.

2.1 BACKGROUND

HPS is a former DON shipyard located in the southeast portion of San Francisco, California, situated on a long promontory extending eastward into San Francisco Bay (Figure 2-1). Purchased by the DON in 1939, the HPS property consists of approximately 866 acres, of which 446 are underwater (DON, 2006). The Bayview/Hunters Point district of San Francisco bounds HPS on the north and west, and the San Francisco Bay borders HPS on the south and east. Bayview/Hunters Point is a low-density demographic area where about half the residents own their homes. More then half of the land in the Bayview/Hunters Point district is used for industrial purposes. Entrance to the base is gained through the gate at the intersection of Innes Avenue and Donahue Street, adjacent to the Bayview/Hunters Point district. Easily identifiable from a distance by its large gantry crane, HPS lies northeast across a narrow brackish water inlet from Candlestick Point, on the west bank of the Bay, south of the Oakland Bay Bridge.

In 1992, the DON divided HPS into five contiguous parcels (A through E) to expedite remedial action and land reuse. In 1996, The DON added a sixth parcel (Parcel F), also known as the offshore areas. In September 2004, the DON designated the landfill area in Parcel E as a separate parcel, Parcel E-2. Currently, HPS has six parcels: B, C, D, E, E-2, and F. Parcel A was transferred to the San Francisco Redevelopment Agency (SFRA) in December 2004 and is no longer DON property. Figure 2-2 identifies all six parcels at HPS and outlines Parcel D, the focus of this addendum. Figure 2-3 identifies radiologically-impacted buildings, sites of former buildings, and outdoor areas in Parcel D. Figure 2-4 shows the Parcel D storm drains and sanitary sewer lines.

2.1.1 Site Description

Parcel D is located in the southeast-central quadrant of HPS as shown in Figure 2-2. Radiologically-impacted sites in Parcel D were used for decontamination training, Naval Radiological Defense Laboratory instrumentation laboratory, stockroom, storage, temporary animal quarters, Materials and Accounts Division, Thermal Branch, machine shop, Engineering Division, library, sampling laboratory, general research laboratories, biological research laboratories, optical laboratories, and field office personnel decontamination, radioactive waste storage, radiography source operations, storage of samples from atomic weapons testing, and storage of radioluminescent devices. One outdoor area (the Naval Radiological Defense Laboratory Site on Mahan Street) was potentially used as a storage site of OPERATION

CROSSROADS material (NAVSEA, 2004). The ship berths (including the piers) in Parcel D have been excluded and moved to Parcel F. However, the actual land mass of the Gun Mole Pier remains in Parcel D. Parcel D boundaries are detailed in Figure 2-3.

Parcel D is bounded by other portions of HPS and by the San Francisco Bay. Most of the land at Parcel D was formerly part of the industrial support area and was used for shipping, ship repair, office, and commercial activities. The historical uses of structures and areas at Parcel D are summarized in Table 2-1. According to San Francisco's Redevelopment Plan (SFRA, 1997), once transferred, Parcel D will be subdivided into blocks and zoned for educational/cultural, mixed use, research and development, industrial, maritime-industrial, and open spaces. The city's proposed reuse areas for Parcel D are shown in Figure 2-3.

2.1.2 Site History

The area of San Francisco known as Hunters Point began its relationship with shipbuilding and repair to support the increasing demand for commercial trade and passenger travel brought on by the mid-nineteenth century gold rush. In 1850, the Hunters Point peninsula was approximately 6,000 feet long and 2,000 feet wide, with a maximum elevation of 290 feet. Between 1909 and 1939, the facilities at Hunters Point were owned and operated by a Bethlehem Steel Company subsidiary and used extensively for commercial and military ship maintenance and repair. HPS was originally a deep-water, two-dry-dock facility when purchased by the DON in 1939. The DON augmented HPS to a full-service, ship repair, and maintenance facility with numerous support buildings, utilities, four additional dry docks, an internal railroad, and living quarters.

Immediately after the end of World War II, the DON used the expansive berthing facilities at HPS for reserve fleet ships returning from the Pacific. In 1946, this berthing and drydocks were used for the radiological decontamination of target and support ships returning from the OPERATION CROSSROADS atomic tests conducted at Bikini Atoll in the Marshall Islands. HPS also used these facilities for the radiological decontamination of many other ships that participated in subsequent atomic weapons tests (NAVSEA, 2004).

The Chief of Naval Operations recognized the need to study the effects of atomic weapons and ordered an organization known as the Radiological Safety Section (RSS) to be formed at HPS in 1946. The RSS became known as the Radiation Laboratory (RADLAB) and on April 21, 1948, the RADLAB was formalized as the Naval Radiological Defense Laboratory (NRDL) (NAVSEA, 2004). The NRDL conducted extensive radiological operations at HPS in support of its mission until it closed in 1969. These operations included management of receipt and packaging of radioactive waste for deep sea disposal.

The shipyard functioned as an active DON repair facility from 1939 through 1974. After HPS ceased to function as an operational DON shipyard in 1974, some HPS buildings and structures were leased to private tenants. The largest tenant, Triple A Machine shop, Inc., conducted ship repair operations throughout HPS druing 1976–1986. Various buildings at HPS have also been leased for maritime and non-maritime industrial and artistic purposes. In addition, the DON continued to use some buildings and structures for on-site oversight activities. The DON resumed shipyard operations at a limited number of facilities at HPS in 1986 when HPS was assigned as an annex to Naval Station Treasure Island.

Shipyard operations were permanently terminated on December 29, 1989. In 1991, HPS was placed on the DON's BRAC list and its mission as a DON shipyard ended on April 1, 1994. Engineering Field Activity West, Naval Facilities Engineering Command (EFA WEST), San Bruno, California, had initial oversight of the closure of HPS. After closure of EFA WEST, this oversight authority was transferred to NAVFAC SW in San Diego, California. Currently the DON's BRAC PMO works with NAVFAC SW and the RASO to manage the site.

Historical radiological operations included the following (NAVSEA, 2004):

- Repair, use, and disposal of radioluminescent commodity items (dial, gauges, and deck markers)
- Use of radioactive sources for gamma radiography for testing of metal and welds
- Use of radioactive sources for calibration laboratory operations to ensure radiation survey instrument accuracy
- Decontamination of and scientific research on ships contaminated during atomic weapons testing
- Use of various radionuclides for scientific research by the NRDL and its predecessors
- Receipt and packaging of radioactive waste for deep sea disposal

Additionally, Mare Island Naval Shipyard used berthing and dry-dock facilities at HPS between 1985 and 1989 for non-radiological work on nuclear-powered ships (NAVSEA, 2004).

The radiologically-impacted Parcel D buildings (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819); former building sites (313, 313A, 317, 322, and 383 area); outdoor areas (Gun Mole Pier and Naval Radiological Defense Laboratory [NRDL] site); and storm drains and sanitary sewers and a synopsis of their use are listed in Table 2-1 (NAVSEA, 2004).

2.1.3 Physical Characteristics of the Site

The terrain in the immediate vicinity of Parcel D is relatively flat, with the former Parcel A the highest point in the area. Most of Parcel D is located in the lowlands, with surface elevations between zero feet to 10 feet above mean sea level (msl). No threatened or endangered species are known to inhabit HPS or its vicinity. There is no viable terrestrial habitat at Parcel D. About 85 percent of the ground surface is covered by pavement and buildings (SulTech, 2007).

Stormwater surface runoff at HPS drains primarily in a sheet-flow pattern from the highlands north and west of Parcel D to the surrounding lowlands. Runoff in Parcel D is collected by the storm drain system and discharged through outfalls to the San Francisco Bay.

The climate is characterized as temperate, or Mediterranean, which typically has moist, mild winters and dry, cool summers. The average annual precipitation in the area is 21.79 inches (DON, 2006). The precipitation occurs mostly during December, January, and February. The prevailing wind direction is west to east (Brown and Caldwell, 1995). There are public residencies within a mile radius of HPS, and the nearest major thoroughfare is Interstate 280, located roughly 5 miles west of the site.

The geology of Parcel D generally consists of artificial fill and undifferentiated sands over Bay Mud over coast-range bedrock (NAVSEA, 2004).

Groundwater under Parcel D and HPS occurs in two aquifers (A- and B-aquifers) and one bedrock water-bearing zone. The A-aquifer is generally unconfined, consisting of unconsolidated artificial fill that overlies the aquitard and bedrock and forms a continuous zone of groundwater across the parcel. The A-aquifer consists mostly of sandy gravel and gravelly sand with limited zones of low-permeability sandy clay (SulTech, 2007). The A-aquifer typically ranges from 10 to 40 feet thick, but averages approximately 25 feet thick (SulTech, 2007).

An aquitard between the A- and B-aquifer inhibits groundwater (aquifer) communication. The aquitard is generally made up of silts and clays of the San Francisco Bay Mud and undifferentiated sediments. The aquitard ranges from zero to 100 feet thick, but is most commonly 40 to 80 feet thick. The aquitard is absent in the northern part of Parcel D where the A-aquifer is in direct contact with the bedrock and is thickest in the southeastern part of the parcel (SulTech, 2007).

The B-aquifer is associated with the Undifferentiated Sedimentary deposits and consists of small, laterally discontinuous permeable sediment lenses of gravel, sand, silty sand, or clayey sand intermingled with the aquitard. The largest B-aquifer area is present near the center of Parcel D. The B-aquifer area at this location is estimated to be approximately 1,500 feet wide by 1,000 feet long. The B-aquifer varies from 20 to 30 feet thick. Groundwater in the discontinuous B-aquifer areas is under semiconfined conditions (SulTech, 2007).

Water in the A- and B-aquifers generally flows toward the Bay. Groundwater within the shallow aquifers is unsuitable for use as a potable water supply (NAVSEA, 2004).

2.1.4 Parcel D Ongoing Radiological Work

A removal action to address the radiologically-impacted storm drains and sanitary sewers of HPS is currently under progress. The Final Basewide Radiological Removal Action, Action Memorandum (DON, 2006) authorizes a time-critical removal action (TCRA) for the storm drain and sanitary sewer lines. The design plan for the removal of storm drains and sanitary sewers in Parcel D (Area 49) was issued along with a Revised Final Base-wide Sanitary and Storm Drain Removal Work Plan (Tetra Tech EC, Inc., 2007). A layout of the storm drains and sanitary sewers is included in the design plan and is shown in Figure 2-4. The trenches and soils resulting from the excavation of the storm drains and sanitary sewers are undergoing a Multi-Agency Radiological Site Survey Investigation Manual (MARSSIM) (NUREG-1575; Department of Defense [DoD] et al., 2000) final status survey as part of the TCRA.

2.1.5 Historical Radiological Assessment and Results

Throughout its history, HPS has been assessed for residual contamination from radiological operations. Historically, assessments were performed by the DON, DON contractors, and federal, state, and local regulatory agencies. These investigations and surveys of the entire HPS site include (NAVSEA, 2004):

- 1946 through 1948 Radiological Safety Section and NRDL decontaminated and surveyed OPERATION CROSSROADS ships and HPS berths and dry docks. This included areas in Parcel D (NAVSEA, 2004)
- 1955 NRDL surveys to decommission NRDL buildings at HPS (NAVSEA, 2004). As part of this activity, buildings 313, 313A, 322, 351A, and 366/351B were surveyed for residual contamination and were determined to meet the release criteria of the time (NAVSEA, 2004). Additional restrictions were placed on the sewer systems and drain lines from Building 351A (NAVSEA, 2004).
- 1969 NRDL survey for dis-establishment of NRDL (NAVSEA, 2004). As part of this activity, building 364 was surveyed for residual contamination, decontaminated, and was determined to meet the release criteria of the time (NAVSEA, 2004).
- 1969 to 1970 Atomic Energy Commission (AEC) survey to verify NRDL's survey results and release buildings for reuse (NAVSEA, 2004). As part of this activity, building 365 was surveyed for residual contamination and was determined to meet the release criteria of the time (NAVSEA, 2004).
- 1974 HPS survey for base closure (NAVSEA, 2004). There are no reports of surveys for Parcel D radiologically-impacted sites.
- April 1978 LFE Environmental Analysis Laboratories, Inc. (LFE) survey of Building 815 (NAVSEA, 2004). There are no reports of surveys for Parcel D radiologically-impacted sites.
- July 1978 RASO survey of Building 815 to confirm LFE survey findings (NAVSEA, 2004). There are no reports of surveys for Parcel D radiologically-impacted sites.

- September 1978 RASO survey of former NRDL buildings (NAVSEA, 2004). RASO conducted cursory surveys in Buildings 364 and 365 (NAVSEA, 2005).
- 1979 RASO resurvey of Building 364 (NAVSEA, 2004). Building 364 was released by using the "survey-clean-survey" method (NAVSEA, 2004).
- 1991 to 2001 surveys conducted for the Remedial Investigation program in four phases: Phases I through IV, including the following interim investigations (NAVSEA, 2004).
  - Phase I consisted of a surface confirmation radiation survey that included air, soil, and groundwater sampling which included cursory surveys at former NRDL site building 364. The survey was initiated in 1991 using hand-held sodium iodide and Geiger-Müller detectors. Elevated alpha and gamma activity was measured at on of the trenches. Additional investigation of the sump area was recommended (NAVSEA, 2004).
  - Phase II did not include any survey activities associated with impacted sites in Parcel D.
  - Phase II to Phase III interim study focused on an interim removal action at the ^{137}Cs spill area behind Building 364 (also known as the "peanut spill"). After excavation was complete, the area was resurveyed, and 20 confirmatory soil samples were collected for ^{137}Cs analysis. Sample results ranged from zero to 1.2 pCi/g of ^{137}Cs, with an average of 0.34 pCi/g. These levels were within the Nuclear Regulatory Commission (NRC) Technical Report Nuclear Regulatory Guide (NUREG)-1500 limit of 2.14 pCi/g, at the 3 mrem per year level for residential areas, which was the release limit of the period
  - Phase III focused on radiological issues related to 1) NRDL operations at HPS; 2) the licensing of general radioactive material use by the NRC in support of NRDL activities; and 3) preliminary findings for buildings and sites used by NRDL in Parcel D. Phase III radiation investigation report recommendations are summarized below:
    - ➢ Building 351A may be considered for release by the Navy for unrestricted public use.
    - ➢ Additional investigation must be performed at the wall of the sump and the utility trench wall at the Building 364 sump site.
  - Phase IV radiological investigation was begun in December 1998 to determine background concentrations of specific radionuclides and to further characterize areas of anomalous count rates that had been identified outside Buildings 364. Samples collected from the Building 364 spill site contained concentrations of radionuclides distinguishable from background or that exceeded the revised site release criteria for ^{137}Cs of 0.13 pCi/g.
  - In June and July 2001, as part of the Phase IV to Phase V interim investigations, TtEMI contracted a survey of the Gun Mole Pier (Regunning Pier). Findings indicated that only background levels of radioactivity were present in the areas surveyed. During 2001, New World Technology performed a removal action at the tank vault behind Building 364. Others had removed the tanks, piping, and

support equipment previously, and the remaining vault surfaces had been identified as exceeding site release criteria. Surveys and soil sampling performed following removal of the concrete vault indicated that no residual contamination remained exceeded site release criteria.

- Phase V, beginning in January 2002, had scoping and characterization surveys performed. Preliminary results were as follows:
  - Building 274 – The Phase V survey was a Class 3 survey and the results were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended.
  - Building 313, 313A, and 322 Sites – The Phase V survey was a Class 3 survey that identified ^{137}Cs contamination present exceeding the release limit. Areas were remediated and resurveyed. The results were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended.
  - Building 317A Site – The Phase V survey a Class 3 survey identified ^{137}Cs contamination present exceeding the release limit. Areas were remediated and resurveyed. The results were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended.
  - Building 351 – The Phase V survey was a Class 3 survey and the results were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended.
  - Building 351A – The Phase V survey was a Class 3 survey and the results identified drain piping and small amounts of soil in crawl space removed and disposed of due to ^{137}Cs contamination. Drainpipe was removed across Cochran Street. Resurvey was complete. Contamination remains outside the back steps of the building. Surveys were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended.
  - Building 364 – The Phase V survey was a Class 3 survey and the results detected ^{137}Cs on building surfaces, piping in building crawl space, and piping/trench outside the rear of the building. Areas remediated and resurveyed. Alpha and beta contamination remains in the building. Remediation of known areas of contamination and a Final Status Survey following remediation was recommended.
  - Building 365 – The Phase V survey was a Class 3 survey and the results were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended.
  - Building 366/351B – The Phase V survey was a Class 1 survey and the results identified ^{137}Cs contamination in building ventilation ducting and inactive floor drains exceeding release limits. Remediation was required.
  - Building 383 Area – The Phase V survey was a Class 3 survey inside the building and the results were insufficient to support the recommendation of unrestricted use. A Class 1 survey was recommended for the outdoor areas.
  - Building 411 – The Phase V survey was a Class 3 survey and the results were sufficient to support the recommendation of unrestricted use. Issuance of the report is pending.

- Gun Mole Pier – The Phase V survey was a Class 3 survey and the results identified areas containing ^{137}Cs exceeding release limits, which were remediated and resurveyed. A characterization survey was recommended.
- Former NRDL Site on Mahan Street – The Phase V survey was a Class 3 survey and the results identified areas containing ^{137}Cs and ^{226}Ra in soils exceeding release limits. Remediation and resurvey are complete. A Class 1 survey was recommended.

2.2 NATURE AND MECHANISM OF RELEASE

The radionuclides listed in Table 2-2 are the ROCs identified for Parcel D (NAVSEA, 2004). The potential sources of contamination were from NRDL activities, the handling and refurbishment of radioluminescent devices, and decontamination of ships returned from atomic bomb tests. In addition, contaminants from radioactive sources used to perform non-destructive analyses are potentially present.

Radioluminescent devices were collected from ships prior to scuttling or retiring from service. The devices were consolidated prior to disposal. In Parcel D, the Building 383 Area is known to be a location for radioactive material consolidation and storage. As an outdoor area, the Gun Mole Pier was used for radioactive pavement decontamination studies, decontamination studies on NRDL Experimental Barge YFN-809 and on a contaminated B-17 aircraft, landing area for NRDL Barge YFNX-16, and also as a decontamination and laboratory facility. Decontamination facilities were also in a structure near Barge YFNX-16. The contaminated experiment was berthed at the Gun Mole Pier and it was a loading point for radioactive wastes. An ocean disposal barge was also loaded from the Gun Mole Pier (NAVSEA, 2004).

Ships from these tests were also part of the era in which radium paint was commonly used on surfaces to allow for viewing of critical control surfaces in low light conditions. Removal, collection, and burial of radium-painted devices from ships of this era were commonly performed prior to scuttling or otherwise retiring a ship. It is therefore likely that radium-painted devices and radium paint residues may be present in the Parcel D outdoor areas (Gun Mole Pier and the NRDL Site on Mahan Street).

2.3 EXTENT OF RADIOLOGICAL CONTAMINATION

Historically, radiological surveys have been performed on the grounds, buildings, and outdoor areas to assess the extent of contamination and types of radionuclides present. The HPS Final Historical Radiological Assessment (HRA) (NAVSEA, 2004) lists structures and areas that are radiologically-impacted. Table 2-1 of this addendum lists the impacted sites and the radionuclides potentially present.

The designation "radiologically-impacted" means that a site has the potential for radioactive contamination based on historical information or is known to contain radioactive contamination.

Assessment of the sites is documented in the HRA (NAVSEA, 2004). The potential for residual radioactive contamination at each impacted site has been determined through an evaluation of historical information, previous radiological survey results, and site reconnaissance. Table 2-3 shows this evaluation of residual radioactivity in Parcel D impacted buildings, structures, and soils.

2.4 RADIONUCLIDE FATE AND TRANSPORT

Radioactive material consists of radionuclides, which are unstable and undergo spontaneous transformations by releasing energy until a stable state is reached. This transformation process is known as radioactive decay and is usually accompanied by the emission of charged particles (e.g., alpha and beta particles) or gamma/x-rays. Alpha particles can travel only short distances and cannot penetrate human skin. Beta particles are generally absorbed in the skin and do not pass through the entire body. Gamma ray radiation can penetrate the human body. Table 2-2 lists the ROCs, their half-lives, and major radiations emitted when decaying (NAVSEA 2004). The radionuclides potentially present in Parcel D were either residue from decontamination of ships or workers; residual contamination as a result of NRDL experiments or tests in structures or land areas, residual contamination from shipyard operations; or released into the sanitary sewers and storm drains. None of the radiologically-impacted areas in Parcel D are known disposal areas.

Each potential ROC is transported through the environment differently. Cobalt typically is not concentrated well by plants and animals. Strontium and radium show a moderate to high degree of food chain transport. Cesium tends to have a high degree of food chain transportability. Plutonium forms insoluble oxides in the environment that are not biologically mobile. In summary, all the ROCs except cesium are fairly immobile once in the soil.

3.0 RISK EVALUATION SUMMARY AND REMEDIATION GOALS

This section summarizes the potential human health risks from exposure to ROCs at Parcel D and presents remediation goals for the identified ROCs. Human health risks were evaluated for exposure to the Parcel D radiologically-impacted buildings, former building sites, outdoor areas, and storm water and sanitary sewer system. Exposure to groundwater was not evaluated because there is no available radiological data associated with Parcel D. The chemical characterization of soil and groundwater at Parcel D is presented in the Revised FS for Parcel D (SulTech, 2007).

3.1 EXPOSURE SCENARIOS

The 1997 redevelopment plan gives planned reuses for the entire Parcel D area. Table 3-1 shows the radiologically-impacted areas of Parcel D, the planned reuse, and associated reuse scenario.

The exposure scenario establishes the receptor parameters to be modeled. The potential receptors considered for evaluation were selected to be consistent with the human health risk assessment provided in the Revised FS for Parcel D (SulTech, 2007) and are as follows:

- Resident (adult and child)
- Industrial worker (adult)
- Recreational user (adult and child)
- Construction worker (adult)

Although the radiologically-impacted land areas in Parcel D only fall into the residential, recreational, and industrial exposure scenarios, all four receptor categories listed above were modeled. These additional evaluations provide information on potential risks for all potential reuses, in the event that the redevelopment plan is revised.

3.2 EXPOSURE PATHWAYS

As discussed in the human health risk assessment in the Revised FS for Parcel D, a complete exposure pathway consists of four elements.

- A source and mechanism of chemical release
- A retention or transport medium (or media in cases involving transfer of chemicals)
- A point of potential human contact with the contaminated medium (referred to as the exposure point)
- An exposure route (such as ingestion) at the contact point

If any of these elements are missing (except in a case where the source itself is the point of exposure), then the exposure pathway is considered incomplete. For example, if receptor contact with the source or transport medium does not occur, then the exposure pathway is incomplete and is not quantitatively evaluated for risk. Similarly, if human contact with an exposure medium is not possible, the exposure pathway is considered incomplete and is not evaluated.

For the potentially contaminated structure surfaces the exposure pathways are external radiation from contaminated surfaces and inhalation of re-suspended contaminated dust.

The exposure pathways for the impacted soils at Parcel D present a more complicated analysis. The complete pathways, based on the four criteria listed above, are external radiation, soil ingestion, inhalation, and drinking water ingestion (e.g., groundwater).

3.3 REMEDIATION GOALS

Remediation goals (RGs) are selected to achieve the RAOs. Table 3-2 identifies the RG for each ROC. The soil RGs were derived from the EPA preliminary remediation goals (PRGs) based on an increased lifetime cancer risk range of 10^{-6} to 10^{-4} for future use scenarios except for ^{226}Ra, which is based on an agreement with EPA (DON, 2006). The RGs for building and equipment surfaces were based on the AEC Reg Guide 1.86 to meet the 25 millirem per year (mrem/y) dose limits of the Nuclear Regulatory Commission. The water RGs were derived from *Radionuclides Notice of Data Availability Technical Document*, (EPA, 2000) by comparing the limits from two criteria and using the most conservative limit.

3.3.1 Constituents of Potential Concern

The ROCs, ^{137}Cs, ^{60}Co, ^{3}H, ^{232}Th, ^{235}U, ^{239}Pu, ^{226}Ra, and ^{90}Sr, have been associated with Parcel D radiologically-impacted buildings (NAVSEA, 2004). The ROCs, ^{137}Cs, ^{232}Th, ^{239}Pu, ^{226}Ra, and ^{90}Sr have been associated with Parcel D radiologically-impacted soils (NAVSEA, 2004). This information is summarized in Table 2-2.

3.3.2 Media of Concern

The media of concern are the remaining radiologically-impacted structures (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819); soils of former building sites (313, 313A, 317, 322 and 383 area); soils in outdoor areas (Gun Mole Pier and NRDL Site on Mahan Street); trenches resulting from sewer and storm line removal; soils of remediated storm drains and sanitary sewers; and groundwater.

3.4 RISK EVALUATION BY REDEVELOPMENT BLOCK

The following sections list the redevelopment blocks and associated evaluation scenario. Figure 2-3 shows the redevelopment blocks, impacted areas and structures, and planned reuses. The radiologically-impacted sites in Parcel D will be identified in each redevelopment block section. Radiologically-impacted sewer and storm drains are present throughout Parcel D and will not be individually listed for a particular development block. The residential scenario provided the most conservative risk estimate and was therefore used to model the risk from ROCs associated with each redevelopment block.

3.4.1 Redevelopment Block A

Redevelopment Block A is located in the northern portion of Parcel D and is identified for research and development use. Redevelopment Block A includes radiologically-impacted buildings 813 (general warehouse and offices, supply storehouse, and Disaster Control Center) with ROC ^{90}Sr and 819 (Sewer Pump Station A) with ROCs ^{137}Cs and ^{226}Ra. Buildings 813 and 819 were evaluated using a Residual Radioactivity-Building (RESRAD-BUILD) residential exposure scenario.

3.4.2 Redevelopment Block 30A

Redevelopment Block 30A includes Building 401 and is in the northwestern portion of Parcel D. Redevelopment Block 30A includes radiologically-impacted Building 401. Building 401 has ROCs of ^{226}Ra from the collection and storage of radioluminescent devices.

Redevelopment Block 30A is identified for mixed-use reuse. Building 401 was evaluated using a RESRAD-BUILD residential exposure scenario.

3.4.3 Redevelopment Block 30B

Redevelopment Block 30B is in the west-central portion of Parcel D and is identified for industrial reuse. It does not include any radiologically-impacted buildings, former building sites, or outdoor areas, and therefore it was not evaluated.

3.4.4 Redevelopment Block 29

Redevelopment Block 29 is in the north-central portion of Parcel D and is identified for educational/cultural reuse. It does not include any radiologically-impacted buildings, former building sites, or outdoor areas, and therefore was not evaluated.

3.4.5 Redevelopment Block DOS-1

Redevelopment Block DOS-1 is in the northeastern corner of Parcel D and is identified for open space reuse. It does not include any radiologically-impacted buildings, former building sites, or outdoor areas, and therefore it was not evaluated.

3.4.6 Redevelopment Block 37

Redevelopment Block 37 is on the west-central area of Parcel D and is identified for industrial reuse. It does not include any radiologically-impacted buildings, former building sites, or outdoor areas, and therefore it was not evaluated.

3.4.7 Redevelopment Block 38

Redevelopment Block 38 is in the central portion of Parcel D. Redevelopment Block 38 includes radiologically-impacted Buildings 408 and 411. Building 408 (furnace-smelter) has ROCs of ^{226}Ra from prior smelting operations and natural thorium in the firebrick. Activities for Building 411 included radioactive source storage and radiography shop activities, and the ROCs are ^{60}Co, ^{137}Cs, and ^{226}Ra.

Redevelopment Block 38 is identified for industrial reuse. Building 408 will be surveyed and dismantled. Therefore, the former Building 408 site was evaluated using a RESRAD residential exposure scenario. Building 411 was evaluated using a RESRAD-BUILD residential exposure scenario.

3.4.8 Redevelopment Block 39

Redevelopment Block 39 is in the east-central portion of Parcel D. Redevelopment Block 39 includes radiologically-impacted Buildings 351, 351A, 364, 365, 366/351B, and former building site 317. Activities inside of Building 351 that may have been the cause of contamination were related to electronic work areas, industrial shops, and NRDL laboratories. The ROCs include ^{90}Sr, ^{137}Cs, ^{232}Th and ^{226}Ra. Activities at Building 351A included the NRDL chemical technology division and applied research branch. The ROCs are ^{90}Sr, ^{137}Cs, ^{232}Th, ^{239}Pu, and ^{226}Ra. Activities at Building 364 included animal irradiation, liquid radioactive waste collection, and hot cell work. The ROCs are ^{90}Sr, ^{137}Cs, ^{235}U, ^{239}Pu, and ^{226}Ra. Activities at Building 365 included personnel decontamination and personnel change house and office activities. The ROCs are ^{90}Sr, ^{137}Cs, ^{235}U, ^{239}Pu, and ^{226}Ra. Activities at Building 366/351B were the NRDL instrument calibration (sources) and offices. The ROCs are ^{90}Sr, ^{137}Cs, and ^{226}Ra. Activities at the former building 317 site included temporary animal quarters for the NRDL, and the ROCs are ^{90}Sr, ^{137}Cs, and ^{226}Ra.

Redevelopment Block 39 is identified for open space reuse. Buildings 364 and 365 will be surveyed and dismantled. Therefore, the former Building 364 and 365 sites were evaluated using a RESRAD residential exposure scenario. Buildings 351, 351A, and 366/351B were evaluated using a RESRAD-BUILD residential exposure scenario. The former site of Building 317 was evaluated using a RESRAD residential exposure scenario.

3.4.9 Redevelopment Block 42

Redevelopment Block 42 is in the south-central portion of Parcel D and is identified for industrial reuse. Redevelopment Block 42 does not include any radiologically-impacted buildings, former building sites, or outdoor areas, and therefore no evaluations were performed.

3.4.10 Redevelopment Block DMI-1

Redevelopment Block DMI-1 is in the southeastern portion of Parcel D. Redevelopment Block DMI-1 includes radiologically-impacted Building 274, former building sites 313, 313A, and 322, the building 383 area, and outdoor areas identified as Gun Mole Pier and the NRDL Site on Mahan Street. Activities at Building 274 included decontamination training and the ROCs are ^{90}Sr, ^{137}Cs, and ^{226}Ra. Activities at the Building 383 area included the collection and storage of radioluminescent devices. The ROCs are ^{90}Sr, ^{3}H, and ^{226}Ra. Activities at the former Building 313, 313A, and 322 sites included use as a NRDL stockroom, NRDL offices, the radiological instrument branch, training facilities, and storage locations. The ROCs are ^{90}Sr, ^{137}Cs, ^{232}Th, ^{239}Pu, and ^{226}Ra. Activities at the Gun Mole Pier included a radioactive pavement decontamination study, decontamination studies on NRDL Experimental Barge YFN-809 and on a contaminated B-17 aircraft. Decontamination facilities were also in a structure near Barge YFNX-16. The ex-INDEPENDENCE was berthed at the Gun Mole Pier and it was a loading point for radioactive wastes. An ocean disposal barge was also loaded from the Gun Mole Pier. The ROCs are ^{90}Sr, ^{137}Cs, ^{239}Pu, and ^{226}Ra. The NRDL Site on Mahan Street was used as a potential storage site of OPERATION CROSSROADS material. ROCs for the NRDL Site on Mahan Street are ^{90}Sr, ^{137}Cs, ^{239}Pu, and ^{226}Ra.

Redevelopment Block DMI-1 is identified for maritime-industrial reuse. Building 274 was evaluated using a RESRAD-BUILD residential exposure scenario. Former building sites 313, 313A, 322, the building 383 area and outdoor areas Gun Mole Pier and the NRDL Site on Mahan Street were evaluated using a RESRAD residential scenario.

3.5 ANALYSIS OF RADIOLOGICAL DOSE AND RISK

As described above, each radiologically-impacted site described above in each redevelopment block was modeled using either RESRAD or RESRAD-BUILD. Appendix A provides a discussion of the input parameters and modeling results for the radiological dose and risk for each radiologically-impacted site. The results were compared against the increased lifetime cancer risk range of 10^{-6} to 10^{-4} and the 25 mrem/y dose limits. Tables 3-3 and 3-4 provide a summary of the modeling results.

The modeling reported in Appendix A is based on the RGs. Actual calculated dose and risk will be based on field measurements from the final status survey results associated with each radiologically-impacted site. For example the risk calculated for survey units one and two of radiologically-impacted site of former Building 114 were calculated to be 4×10^{-7} and 2×10^{-7} respectively.

The modeling was performed with conservative input parameters to ensure that uncertainties would be minimized, and a separate set of models and results for uncertainty analysis would not be needed. Uncertainty analysis for the various modeling input parameters, as well as various assumptions required for the modeling, are discussed in Appendix A.

3.6 COMBINED CHEMICAL AND RADIOLOGICAL RISK

Estimates of the lifetime risk of cancer to exposed individuals resulting from radiological and chemical risk assessments may be summed in order to determine the overall potential human health hazard associated with a site (Chapter 10, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual*, EPA/540/1-89/002, December, 1989).

To combine the chemical risk and radiological risk, the same approach used in the Revised FS for Parcel D to calculate chemical risk must be taken, namely, calculating total risk from ROCs inclusive of background and calculating incremental risk from the ROCs present at levels that do not include background and calculating incremental risk from the ROCs present at levels that do not include background. Of the ROCs for Parcel D only ^{226}Ra is naturally occurring. ^{137}Cs and ^{90}Sr may be present in trace quantities because of fallout resulting from nuclear weapons testing. In addition, naturally occurring thorium may be present in firebricks located throughout the site. For the purposes of the radiological modeling, the background concentration for the ROCs other than ^{226}Ra are assumed to be essentially zero (i.e., zero pCi/g). The ^{226}Ra background concentration is assumed to be the measured background level of 0.5 pCi/g from previous background sampling activities in Parcel D (Building 813 parking lot).

To estimate the total risk from radiologically-impacted buildings, the background concentration of the ROCs is assumed to be zero (i.e., zero disintegration per minute [dpm]/100 square centimeters [cm^2]). This is a reasonable assumption since none of the ROCs are found in building materials except for ^{226}Ra, which can be found in building material made of earthen materials (i.e., cement, ceramic tiles). However, as a conservative modeling measure, the background concentration of ^{226}Ra in building materials is also assumed to be zero.

The combined total risk (a combination of radiological and chemical total risks) is shown in Table 3-5. The combined incremental risk (a combination of radiological and chemical incremental risks) is shown in Table 3-6.

4.0 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, AND PROCESS OPTIONS

The purpose of this section is to identify and screen potentially applicable alternatives for removing, stabilizing, containing, or reducing risk and exposure from the ROCs present in buildings (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819); soils of former building sites (313, 313A, 317, 322, and 383 area); outdoor areas (Gun Mole Pier and the NRDL Site on Mahan Street); and trenches, piping, and soils associated with storm drains and sanitary sewers at Parcel D. The identification and screening of alternatives include:

- Development of RAOs for soils and structures for the ROCs identified in Section 3.3.1 above.
- Development of GRAs (e.g., containment and excavation) that may be taken to satisfy the RAOs.
- Delineation of target remediation sites to which GRAs might be applied.
- Identification and evaluation of technologies applicable to each GRA on the basis of their effectiveness to achieve the RAOs, technical and administrative implementability, and cost.

Each of these steps is discussed in the following sections.

4.1 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals for protecting human health and the environment. Each RAO should specify 1) the ROC, 2) the exposure route and receptors, and 3) an acceptable contaminant concentration or range of concentrations for each medium of concern (such as soil and structures). RAOs include both an exposure pathway and a contaminant concentration in a given medium because protectiveness may be achieved in two ways: limiting or eliminating the exposure pathway, or reducing contaminant concentrations.

Separate RAOs are typically developed for human health receptors and for ecological receptors. No ecological RAOs were developed because most of the land is paved and the parcel contains no identified terrestrial habitat (SulTech, 2007).

The RAOs for radiologically-impacted sites are as follows:

- Prevent ingestion, dermal contact, or inhalation of ROCs in concentrations that significantly exceed background concentrations.
- Assure that the total effective dose from radiologically-impacted sites to any member of the public does not exceed 25 mrem/y.

- Ensure that the increased lifetime cancer risk does not exceed the 10^{-6} to 10^{-4} risk range for future-use scenarios.

The NCP provides a range of cancer risks from 10^{-6} to 10^{-4} for the DON as lead agency along with its regulatory partners to use when making decisions on remedies for contaminated sites. Cancer risks less than 10^{-6} (one in a million) are not considered to warrant a cleanup response. Cancer risks greater than 10^{-4} (one in a ten thousand) excess cancer risk warrant action to reduce exposure. NCP §300.430(e)(2)(A) provides factors that must be considered when making decisions regarding RAOs and remedial alternatives in the context of the NCP Risk Management Range as follows:

> Preliminary remediation goals for carcinogens are set at a 10^{-6} excess cancer risk as a point of departure, but may be revised to a different risk level within the acceptable risk range based on the consideration of appropriate factors including but not limited to exposure factors, uncertainty, and technical limitations (NCP preamble at 55 Fed. Reg. 8717, March 8, 1990).

There is a high level of confidence that the cancer risks are representative of the site conditions and the decisions at the 10^{-4} risk level may be acceptable.

4.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d)(l) of CERCLA requires remedial actions attain (or the decision document must justify the waiver of) any ARAR that includes environmental regulations, standards, or criteria promulgated under federal or more stringent state laws. An ARAR may be either applicable or relevant and appropriate, but not both.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site. A requirement must be determined to be both relevant and appropriate to be considered an ARAR.

Section 121(e) of CERCLA exempts any response action conducted entirely on site from having to obtain a federal, state, or local permit when the action is carried out in compliance with Section 121. In addition, on-site actions need only comply with the substantive requirements of ARARs, and not with the corresponding administrative procedures, such as administrative reviews and record-keeping requirements. Off-site actions must comply with all legally applicable requirements, both substantive and administrative.

The identification of ARARs is based on site-specific factors, including potential remedial actions, chemicals and compounds found at the site, physical characteristics of the site, and the location of the site. ARARs are usually divided into three categories: chemical-specific, location-specific, and action-specific.

As the lead federal agency, the DON has primary responsibility for identification of potential ARARs for HPS Parcel D. The final identification of ARARs will be in a final Record of Decision (ROD). EPA guidance recommends that the lead federal agency consult with the state when identifying potential state ARARs for remedial actions (EPA, 1988). In October 2003, the DON requested that the state identify potential ARARs. On December 24, 2003, Department of Toxic Substances (DTSC) responded and identified potential state ARARs. This response also included potential state ARARs identified by the Department of Fish and Game and the California Department of Public Health (CDPH). The Water Board also submitted a response that identified potential state ARARs for remediation of soil and groundwater. To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be 1) a standard, requirement, criterion, or limitation under a state environmental or facility siting law; 2) promulgated (of general applicability and legally enforceable); 3) substantive (not procedural or administrative); 4) more stringent than the federal requirement; 5) identified by the state in a timely manner; and 6) consistently applied. Requirements identified by these state agencies that the DON identified as potential ARARs are presented in Appendix C.

The sections below summarize the potential federal and State of California radiological ARARs. The non-radiological ARARs are discussed in Section 4.2 of the Revised FS for Parcel D (SulTech, 2007).

4.2.1 Potential Chemical-specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical cleanup values. Chemical-specific ARARs for soil and structures are described in Table 4-1 and summarized below.

4.2.1.1 Soil

Section 4.2.1.1 of the Revised FS for Parcel D discusses potential federal chemical-specific ARARs for soil. Parcel D contains radiologically-impacted soil; therefore, ARARs are included for soil. No federal requirements for radioactive material are potentially applicable. However, the substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for the remediation of soil and solid waste containing radioactive material at the site:

- Standards for Protection Against Radiation (10 C.F.R. § 20.1402)

California state requirements (California Code of Regulations [C.C.R.] title [tit.] 17, § 30253) are not more stringent than federal ARARs at 10 C.F.R. pt. 20. Therefore, the state requirements are not potential ARARs

4.2.1.2 Groundwater

Section 4.2.1.2 of the Revised FS for Parcel D discusses potential federal and state chemical-specific ARARs for groundwater. The discussion includes the federal maximum contaminant levels (MCLs) promulgated by EPA under the Safe Drinking Water Act. This addendum specifically includes 40 C.F.R. § 141.66 MCLs for radionuclides.

4.2.1.3 Surface Water

Section 4.2.1.3 of the Revised FS for Parcel D discusses potential ARARs associated with surface waters. No additional ARARs for surface waters are included in this addendum.

4.2.1.4 Structures

Parcel D has structures (i.e., buildings) that are radiologically-impacted; therefore ARARs are included for radiologically-impacted structures. No federal requirements for radioactive material are potentially applicable. However, the substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for the remediation of radiologically-impacted structures:

- Standards for Protection Against Radiation (10 C.F.R. § 20.1402)

4.2.2 Potential Location-specific ARARs

Section 4.2.2 of the Revised FS for Parcel D discusses potential federal location-specific ARARs. No additional location-specific ARARs are included in this addendum.

4.2.3 Potential Action-specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities. These requirements are triggered by the specific remedial activities conducted at the site and indicate how a selected remedial alternative should be achieved. The DON has identified potential action-specific ARARs for radiologically-impacted soil and structural alternatives evaluated in this addendum. These action-specific ARARs supplement the action-specific ARARs discussed in Section 4.2.3 of the Revised FS for Parcel D.

4.2.3.1 Soil Alternatives

Remedial alternatives evaluated for Parcel D soil include the following types of actions for radioactive material remediation, as discussed in more detail in Section 5.0: 1) no action; 2) institutional controls (ICs); 3) excavation (removal of the storm drains, sanitary sewers, and radioactive materials at the Gun Mole Pier and NRDL Site on Mahan Street) and ICs; 4) covering and ICs; and 5) excavation, covers, and ICs. The following discussion summarizes potential radiological ARARs for these actions.

Institutional Controls

The DON has identified the substantive provisions of the state requirements as potential relevant and appropriate ARARs for ICs. Any ICs identified for soils will be done so for chemical constituents, and are subject to the restricted release requirements generally applicable to land-use restrictions specified in Part 4.2.3.1 of the Revised FS for Parcel D (SulTech, 2007).. .

Excavation

The DON has identified that the substantive provisions of the federal and state requirements as potential ARARs for excavation of soil and other wastes generated during implementation of the alternatives as the same for chemicals and radionuclides. These ARARs are found in Section 4.2.3.1 of the Revised FS for Parcel D (SulTech, 2007).

Covers for the Soil

The DON has identified that the substantive provisions of the federal and state requirements as potential ARARs for constructing the redevelopment block covers during implementation of the alternatives for chemicals. The ARARs are found in Section 4.2.3.1 of the Revised FS for Parcel D (SulTech, 2007).

4.2.3.2 Structures

Remedial alternatives evaluated for Parcel D radiologically-impacted structures include the following types of actions: 1) no action; and 2) survey, decontamination, disposal, and release to the remediation goals in Table 3-2. The substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for radiologically-impacted structures:

- Standards for Protection Against Radiation (10 C.F.R. § 20.1402)

4.3 GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS ANALYSES

GRAs describe those actions that will satisfy RAOs for soil, groundwater, and structures. Unlike non-radioactive hazardous substances, which have the ability to be altered by physical, chemical, or biological processes that can reduce or destroy the hazard itself, radioactive substances generally cannot be similarly altered or destroyed. Since destruction of radioactivity is not an option, response actions at radioactively contaminated sites use the concepts of "Time, Distance, and Shielding." Time allows the natural decay of the radionuclide to take place, resulting in reduction in risk to human health and the environment. Distance and shielding from the radioactive material rapidly reduce the risk from radiation by reduction of the intensity of the imparted energy (EPA, 1996). A process option is defined as a specific technology used to carry out a general response action. The following GRAs have been identified for Parcel D:

Soil

- *No Action:* Under this GRA, no further response action will be conducted at the site.
- *Institutional Controls:* These include non-engineered methods such as administrative and/or legal controls that minimize the potential for human exposure to contaminated material by limiting land or resource use and that protect the integrity of remedial action.
- *Containment:* This GRA includes construction of a physical barrier (distance/ shielding) to eliminate or reduce the possibility of contaminant migration and exposure. This action also includes renovating and maintaining existing Parcel D covers.
- *Removal/Disposal:* This GRA includes soil remediation, excavation of radioactively contaminated soil, screening to segregate soil exceeding the remediation goals (Table 3-2), and disposal at an appropriate off-site waste disposal facility. Ongoing work at HPS currently includes removal and disposal of the storm drain and sanitary sewer lines.

Structures

- *No Action:* Under this GRA, no further response action will be conducted at the site.
- *Survey of Impacted Sites:* A radiological survey of all impacted sites and structures will be performed according to the guidance provided in the MARSSIM (NUREG-1575; DOD et al., 2000) to determine actual site conditions and provide information to guide decontamination and disposal.
- *Scabbling and Demolition:* This includes removal of thin layers of contaminated building material to remove the surface contamination and/or complete demolition and removal of contaminated structures. All removal actions will be guided by radiological survey data, and followed up with additional progress of work surveys to ensure removal of the ROCs.

- *Removal/Disposal:* This GRA includes building remediation/demolition, excavation of radioactivity exceeding the remediation goals (Table 3-2), and disposal at a licensed off-site waste disposal facility.

4.4 ANALYSIS OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS

General response actions selected for this Radiological Addendum to the Revised FS for Parcel D underwent an initial screening and analysis. During the initial screening, the range of technology types and process options were evaluated in terms of technical implementation, site conditions, waste characteristics, contaminant properties, and the ability to meet NCP requirements and RAOs. The results of the initial screening are summarized in Table 4-2. The GRAs and process options carried forward from the initial screening were then analyzed in terms of effectiveness, implementability, and cost. The screening and analysis of GRAs and process options is presented for soil, groundwater, and structures in Table 4-3.

4.4.1 Evaluation of Applicable Soil and Structures Process Options

Potentially applicable GRAs identified for soil at Parcel D consist of 1) no action, 2) institutional controls (for chemicals), 3) removal, and 4) containment. The initial screening of process options for the remedial technology types for these GRAs is shown in Table 4-2. This table presents the various technology types, process options, and results of the screening analysis for each GRA for soil and structures. The rationale for those options eliminated from further evaluation is presented in Table 4-2; these options are not discussed further.

All four GRAs are retained for further evaluation, including no action. The majority of the GRA for treatment of chemicals was eliminated and all were eliminated for ROCs during the initial screening of process options for soil at Parcel D. Institutional controls, removal (including soil screening), and containment were retained for evaluation.

Those process options retained during the initial screening were evaluated for effectiveness, implementability, and cost, and are discussed in this section. Table 4-3 summarizes the results for this evaluation.

4.4.1.1 No Action

The NCP requires that the no-action alternative be carried through the detailed analysis of alternatives. Under the no-action response, no remedial action is taken. Soil would be left as is without implementing any institutional controls, containment, removal, treatment, or other mitigating actions. Because soil at Parcel D poses a risk to human health and the environment under the anticipated future land-use scenario, the no-action response would not be an effective alternative that meets the requirements of CERCLA. No cost is associated with this option because no action is taken. The no-action option will be retained for further evaluation as a remedial alternative for comparison only, as required under the NCP.

4.4.1.2 Institutional Controls

Land use restrictions for radiological constituents are not applicable as no radiological contamination above the release criteria shall be left in place at Parcel D. Any ICs identified for soils will be done so for chemical constituents, and are subject to the restricted release requirements generally applicable to land-use restrictions specified in Part 4.2.3.1 of the Revised FS for Parcel D.

Any excavation into a soil cover/cap selected as a remedy for chemical constituents in Parcel D must be approved by the Federal Facility Agreement (FFA) Signatories and the California Department of Health Services as provided by the Parcel D RMP. The integrity of the cover/cap must be restored upon completion of excavation as provided by the Parcel D RMP and approved by the FFA Signatories.

4.4.1.3 Removal

Removal is an effective process option for soil at Parcel D and involves soil screening and removing and transporting contaminated material off site to a licensed disposal facility. Important considerations with the removal and disposal process option include excavation volume, fugitive emissions, hauling distance, and disposal facility for final deposition. Excavations will be to a depth that a calculated excess lifetime carcinogenic risk (ELCR) in the risk range of 10^{-6} to 10^{-4}. The excavation cleanup criteria would be specific to the reuse type and ROC-specific RAOs specified in Section 4.1.

Excavation is effective and implementable for many of the ROCs found in soil at Parcel D and therefore excavation and off-site disposal process options will be retained for development and evaluation of remedial alternatives.

4.4.1.4 Containment

Containment processes are intended to isolate the chemically contaminated soil or sediment to prevent direct exposure and contaminant migration. The most appropriate containment process options for soil at Parcel D are surface covers. Cover materials used to prevent direct exposure may include clean soil, asphalt, or concrete; the material to be used will depend on the planned reuse associated with each redevelopment block.

The general approach for implementing covers includes:

> Where covers are needed, areas will be covered with a durable material that will not break, erode, or deteriorate such that the underlying soil becomes exposed. Standard construction practices for roads, sidewalks, and buildings would likely be adequate to meet this performance standard. All covers must achieve a full cover over the entire redevelopment block that ensures an ELCR not to exceed the 10^{-6} to 10^{-4} risk range. The

exact nature and specifications for covers can vary from block to block, but all covers must meet the performance standard of preventing exposure to soil and being durable.

All existing or newly installed covers will need to be maintained. Maintenance includes inspections and repairs for covers left in place during future land use and replacement of covers if future land use requires excavation or demolition of the covers during construction. Any modification of existing hardscape will be subject to the institutional controls described earlier.

The process option of covers is effective, so long as the covers are properly installed and maintained and are replaced after excavation or demolition during redevelopment. The implementability and cost of covers are expected to be moderate because they are already in place at most of the redevelopment blocks at Parcel D.

The implementability evaluation focused on technical, as well as institutional aspects of implementability, such as the ability to obtain necessary permits and approvals, availability of equipment and skilled workers, extensiveness of knowledge required to implement the process option, and the need for treatment or disposal of process waste.

The cost evaluation included semi-quantitative analysis based on engineering judgment and the unit costs given in the Revised FS for Parcel D (SulTech, 2007).

4.4.2 Evaluation of Applicable Groundwater Process Options

Potentially applicable GRAs identified for groundwater at Parcel D consist of 1) no action, 2) institutional controls, 3) monitoring, and 4) treatment for volatile organic compounds (VOCs) and metals with reduced monitoring. The initial screening of process options for the remedial technology types for these groundwater GRAs is shown in Table 4-2. This table presents the various technology types, process options, and results of the screening analysis for each groundwater process option. Removal and containment of groundwater were not retained after the initial screening based on difficulty of implementation and poor effectiveness. A summary of the selected GRAs is shown in Table 4-3.

4.4.2.1 No Action

The NCP requires that the no-action alternative be carried through the detailed analysis of alternatives. Under the no-action response, no remedial action is taken. Impacted structures would be left as is without implementing any survey or decontamination. Because impacted structures at Parcel D may pose a risk to human health and the environment under the anticipated future land-use scenario, the no-action response would not be an effective alternative that meets the requirements of CERCLA. No cost is associated with this option because no action is taken. The no-action option will be retained for further evaluation as a remedial alternative for comparison only, as required under the NCP.

4.4.2.2 Institutional Controls

As previously discussed in Section 4.4.1.2, institutional controls will be used to implement land use and access restrictions used to limit the exposure of future landowner(s) and/or user(s) of the property to hazardous substances and to maintain the integrity of the remedial action until remediation is complete and remediation goals have been achieved. Section 4.3.2.2 of the Revised FS for Parcel D provides a discussion of institutional controls relative to groundwater.

4.4.2.3 Treatment

Groundwater treatment for the natural recovery of ROCs is retained for further development. ROCs are allowed to naturally attenuate via decay, dispersion, dilution, or adsorption; requires monitoring to assess recovery rates and success.

4.4.2.4 Groundwater Monitoring

Groundwater monitoring for the ROCs will be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.

4.4.3 Evaluation of Applicable Structure Process Options

Potentially applicable GRAs identified for impacted structures at Parcel D consist of 1) no action; and 2) survey, decontamination, disposal, and release to meet the remediation goals listed in Table 3-2. The initial screening of process options for the remedial technology types for these GRAs is shown in Table 4-2.

4.4.3.1 No Action

The NCP requires that the no-action alternative be carried through the detailed analysis of alternatives. Under the no-action response, no remedial action is taken. Impacted structures would be left as is without implementing any survey or decontamination. Because impacted structures at Parcel D may pose a risk to human health and the environment under the anticipated future land-use scenario, the no-action response would not be an effective alternative that meets the requirements of CERCLA. No cost is associated with this option because no action is taken. The no-action option will be retained for further evaluation as a remedial alternative for comparison only, as required under the NCP.

4.4.3.2 Survey of Impacted Sites

A Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NUREG-1575; Department of Defense [DoD] et al., 2000) radiological survey would be performed on all impacted sites. The impacted sites would be divided into survey units and any ROCs at or above Table 3-2 remediation goals would be remediated.

4.4.3.3 Scabbling and Demolition

Scabbling is defined as roughly dressing rock (in this case building walls, floors, ceilings) and this process would be accomplished using powered mechanical tools. Demolition could include destruction of structure areas or the entire structure found to have ROCs above the cleanup goals.

Disposal of scabbled materials and/or demolished radioactively contaminated structures into a facility licensed to receive low-level radioactive waste. Scabbling and demolition is effective and implementable for many of the ROCs found in structures at Parcel D and therefore off-site disposal process options will be retained for development and evaluation of remedial alternatives.

These processes would be followed by more surveys to prove that ROCs above the Table 3-2 remediation goals are eliminated.

5.0 DEVELOPMENT AND DESCRIPTION OF REMEDIAL ALTERNATIVES

The remedial action alternatives for ROCs at Parcel D were developed by combining different technologies and process options corresponding to different GRAs. The target remediation areas were also considered while developing the alternatives. This process ensured the development of a range of alternatives from those involving removal of radiologically contaminated soil, groundwater, or structures posing unacceptable risk to human health to those involving little or no treatment but providing protection to human health by minimizing exposure to the remaining ROCs of Parcel D. The alternatives include:

5.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Process options were developed and screened as described in Section 4.0. The retained process options were combined into remedial alternatives to meet RAOs and to satisfy ARARs. The remedial alternatives were derived using experience and engineering judgment to formulate process options into the most plausible site-specific remedial actions.

The DON's strategy for groundwater remedial alternatives is to eliminate complete exposure pathways to the potential receptors and to monitor the known affected areas while the aquifer recovers. Various institutional controls are included in the remedial alternatives for groundwater to assure that the RAOs and ARARs are satisfied.

The DON's strategy for radiologically-impacted buildings remedial alternatives is to eliminate complete exposure pathways to the potential receptors to assure that the RAOs and ARARs are satisfied. The DON's strategy for radiologically-impacted soil remedial alternatives is to remove the contaminated soils from former building sites, trenches resulting from sewer and storm line removal, soils from remediated storm drains and sanitary sewers, and soils from the Gun Mole Pier and the NRDL Site on Mahan Street by excavation and disposal to eliminate complete exposure pathways to the receptors. In certain chemically-driven remedial alternatives, soil covers will eliminate exposure to potential unacceptable risk. Covers will use existing materials (rehabilitated as necessary) and newly installed materials to eliminate exposure.

Groundwater remedial alternatives include five-year reviews of institutional controls to confirm that the remedies are continuing to protect human health and the environment. Costs for five-year reviews, as well as other long-term activities, are included in the cost estimates for all alternatives.

The alternatives developed for further analysis for soil, groundwater, and buildings are presented in the following sections.

5.1.1 Alternatives Developed for Soil

Section 5.1.1 of the Revised FS for Parcel D discusses the alternatives developed for soils that are summarized below.

Alternative S-1: No Action

For this alternative, no remedial action would be taken. Soil would be left in place without implementing any response actions. The no-action response is retained throughout the evaluation process as required by the NCP to provide a baseline for comparison with other alternatives.

Alternative S-2: Institutional Controls and Maintained Landscaping

Alternative S-2 consists of institutional controls and maintained landscaping that, together, will meet all applicable or relevant and appropriate requirements and remedial action objectives. The institutional controls include access restrictions and covenants to restrict use of property that will be implemented parcel-wide for all of the redevelopment blocks. The maintained landscaping would prevent potential exposure to asbestos (that may be present in surface soil and transported by wind erosion) that would not be addressed by institutional controls alone.

Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls

Alternative 3 consists of soil excavation and off-site disposal, maintained landscaping, and institutional controls similar to those of Alternative S-2. In areas where lead and polyaromatic nuclear hydrocarbons (PAHs) are constituents of concern (COCs), soil above remediation goals will be excavated and disposed of at an off-site facility. This alternative will provide a more permanent remedy to reduce the volume and toxicity of contaminants where excavation is feasible, as described in the Revised FS for Parcel D (SulTech, 2007). Areas of bare or minimally vegetated soil that have been disturbed by excavation or construction activities and not restored with a cover will be covered by maintained landscaping as described in Alternative S-2.

Alternative S-4: Covers and Institutional Controls

Alternative S-4 consists of covers to remove the exposure pathway to soil contaminants and institutional controls similar to Alternatives S-2 and S-3. Covers included in this alternative may include new covers and existing or future building footprints, roads, parking lots, and maintained landscaping. Institutional controls are included in this alternative for both short-term and long-term mitigation of risk exposure. In addition to institutional controls similar to those required for Alternative S-2, institutional controls will also be included that would require maintenance of covers.

Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls

Alternative S-5 consists of a combination of soil excavation, disposal, covers, and institutional controls. This alternative was developed as a combined alternative to 1) remove and dispose of lead and PAHs as described in Alternative S-3; 2) implement and maintain block-wide covers as described in Alternative S-4; and 3) implement parcel-wide institutional controls as described in Alternative S-2.

5.1.2 Alternative Developed for Groundwater

A Parcel D ROC groundwater monitoring program currently does not exist, nor has the groundwater been completely characterized. The following groundwater alternatives include ROC sampling and analysis. Appropriate alternatives will be evaluated upon ROC groundwater data review.

Alternative GW-1 No Action

For this alternative, no remedial action will be taken for groundwater. Groundwater conditions will be left as is, without implementing any response actions. The no-action response is retained throughout the evaluation process as required by the NCP to provide a baseline for comparison with other alternatives.

Alternative GW-2: Long-term Groundwater Monitoring and Institutional Controls

Alternative GW-2 consists of groundwater monitoring and institutional controls. This alternative was developed as a method for monitoring contaminants present at low concentrations in groundwater. Additionally, groundwater monitoring would be used to confirm site conditions and ensure that, over time, the potential exposure pathways remain incomplete. Institutional controls are also included in this alternative to effectively manage risk by preventing exposure and use of the groundwater. Groundwater monitoring for the ROCs would be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.

Alternatives GW-3A and GW-3B: In-Situ Treatment for Volatile Organic Compounds (VOCs), Groundwater Monitoring for Metals and VOCs, and Institutional Controls

Alternatives GW-3A and GW-3B consist of in situ treatment of the VOC contaminant plumes. GW-3A and GW-3B do not treat metals in groundwater. These alternatives also include groundwater monitoring for ROCs, metals, and VOCs and institutional controls similar to those described for Alternative GW-2. Alternatives GW-3A and GW-3B involve using different in situ treatment reagents (a biological substrate for 3A and zero-valent iron for 3B), to treat VOCs. The reagents are described in Section 5.3.3. Because Alternatives GW-3A and GW-3B do not treat metal COCs, metals would be monitored under this alternative. Alternatives GW-3A and GW3B are intended to reduce the required time to meet the groundwater RAOs, and, as a result, the length of groundwater monitoring and possibly the time required for the ICs. The institutional controls in Alternatives GW-3A and GW-3B would be the same as the ICs in Alternative GW-2.

Alternatives GW-4A and GW-4B: In-Situ Treatment for VOCs and Metals, Groundwater Monitoring, and Institutional Controls

Alternatives GW-4A and GW-4B consist of in-situ treatment for both VOC and metal contaminants in groundwater. These alternatives also include groundwater monitoring for ROCs, metals, and VOCs and ICs. Alternatives GW-4A and GW-4B involve using biological and zero-valent iron in-situ treatment reagents for VOCs and metals as described in Alternatives GW-3A and GW-3B. Alternatives GW-4A and GW-4B are intended to further reduce the time to meet the groundwater RAOs, the length of groundwater monitoring, and the time required for the institutional controls.

5.1.3 Alternatives Developed for Radiologically-Impacted Sites

The following alternatives were developed for radiologically-impacted sites in Parcel D.

Alternative R-1: No Action

No remedial action will be taken for this alternative. Parcel D building and structure conditions will be left as is, without implementing any response actions. The no-action response is retained through the evaluation process as required by the NCP to provide a baseline for comparison with other alternatives.

Alternative R-2: Survey, Decontamination, Excavation, Disposal, and Release

Alternative R-2 consists of survey of buildings, soils of former building sites, trenches resulting from sewer and storm line removal, soils of remediated storm drains and sanitary sewers to meet the remedial action objectives, and soils of outdoor areas Gun Mole Pier and the NRDL Site on Mahan Street; decontamination of radiologically-impacted buildings and dismantlement if necessary (if remedial actions are not successful or if remedial actions affect the stability of the structure); excavation of soils of former building sites, trenches resulting from sewer and storm line removal, soils of remediated storm drains and sanitary sewers, and soils of outdoor areas Gun Mole Pier and the NRDL Site on Mahan Street to meet the remedial action objectives.

5.2 DESCRIPTION OF SOIL REMEDIAL ALTERNATIVES

Soil at Parcel D presents a potential unacceptable risk to human health under anticipated future land-use scenarios. Section 5.2 of the Revised FS for Parcel D provides a description of the soil remedial alternatives. These alternatives included radiological support; however, they do not include the remedial activities targeting the ROCs in the radiologically-impacted sites.

5.3 DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES

Section 5.3 of the Revised FS for Parcel D provides a description of the groundwater remedial alternatives. Groundwater monitoring for the ROCs would be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.

5.4 DESCRIPTION OF RADIOLOGICALLY-IMPACTED SITES REMEDIAL ALTERNATIVES

Radiologically-impacted sites at Parcel D present a potential unacceptable risk to human health under anticipated future land-use scenarios. The remedial alternatives were developed for radiologically-impacted sites: 1) a no-action alternative; 2) a survey, decontamination, disposal, and release; 3) a survey, decontamination, excavation, disposal, and release. These alternatives are described in the following sections.

5.4.1 Alternative R-1: No Action

Under Alternative R-1, no remedial action would be taken. Radiologically-impacted sites would be left as is without implementing any institutional controls, containment, removal, or other mitigating actions. The no-action response is retained through the evaluation process as required by the NCP to provide a baseline for comparison with other alternatives.

5.4.2 Alternative R-2: Survey, Decontamination, Excavation, Disposal, and Release

Under Alternative R-2 remedial actions would be taken to remove ROCs present at radiologically-impacted buildings above the RGs. These remedial actions may consist of decontamination of radiologically-impacted buildings and dismantlement of building structures if remediation is not successful or if remedial actions affect the stability of the structure. The buildings would be surveyed to verify that no residual radioactivity is present above the RGs.

The soils of former building sites and outdoor areas would be surveyed to verify that no residual radioactivity is present above the RGs. Limited soils excavation at former building sites may be performed to remove radiologically-impacted soils.

The trenches resulting from sewer and storm line removal, and soils of remediated storm drains and sanitary sewers would be surveyed to verify that residual radioactivity is not present above the RGs. The radiologically-impacted storm drains and sanitary sewers would be removed under this alternative.

Surface scans and sampling would be performed at the Gun Mole Pier and former NRDL site on Mahan Street. Soil excavations would be performed to completely remove radiological contamination. Surveys to verify that residual radioactivity is not present above the RGs would be performed. The excavated areas would be backfilled with clean material to grade.

6.0 DETAILED ANALYSIS OF ALTERNATIVES

This section provides a detailed analysis of each remedial alternative developed in Section 5.0. This information will be used to help select a final remedy for Parcel D. The alternatives are evaluated using criteria based on the statutory requirements of CERCLA as amended by the Superfund Amendments and Reauthorization Act, Section 121; the NCP; and *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

The NCP specifies nine criteria to be used in the comparative analysis. The first two are threshold criteria that must be satisfied for a remedy to be eligible for selection; the next five are balancing criteria used to evaluate the comparative advantages and disadvantages of the remedies; and the final two are modifying criteria generally taken into account after agency and public comments are received on the proposed plan. The nine criteria are listed below.

Overall protection of human health and the environment: This criterion describes how each alternative, as a whole, protects human health and the environment and indicates how each hazardous substance source is to be eliminated, reduced, or controlled.

Compliance with ARARs: This criterion evaluates each alternative's compliance with ARARs, or, if an ARAR waiver is required, how the waiver is justified. ARARs consider location-specific, chemical-specific, and cleanup action-specific concerns.

Long-term effectiveness and permanence: This criterion evaluates the effectiveness of each alternative in protecting human health and the environment after the remedial action is complete. Factors considered include magnitude of residual risks and adequacy and reliability of release controls.

Reduction of toxicity, mobility, or volume through treatment: This criterion evaluates the anticipated capability of each alternative's specific treatment technology to reduce the toxicity, mobility, or volume of hazardous substances.

Short-term effectiveness: This criterion addresses the effectiveness of each alternative in protecting human health and the environment during the construction and implementation phase. Factors considered include:

- Exposure of the community during implementation
- Exposure of the workers during construction
- Environmental impacts
- Time required to complete the remedial action and achieve RAOs

Implementability: This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of the required services and materials during its implementation. Factors considered include:

- Ability to construct the technology
- Reliability of the technology
- Monitoring considerations
- Availability of equipment and specialists

Cost: This criterion evaluates the capital and operation and maintenance (O&M) costs for each alternative. Capital and O&M cost estimates are order-of-magnitude level estimates and have an expected accuracy of minus 30 to plus 50 percent (EPA, 2000).

Community Acceptance: This criterion evaluates issues and concerns the public may have about each alternative. This criterion will be assessed after community comments have been received on the Revised FS for Parcel D, this addendum, and the proposed plan.

Regulatory Agency Acceptance: This criterion evaluates technical and administrative issues and concerns the regulatory agencies may have about each alternative. This criterion will be assessed after agency comments are received on the Revised FS for Parcel D, this addendum, and the proposed plan.

In the following sections each remedial alternative is evaluated to the two threshold and five balancing NCP criteria, and subsequently compared with other alternatives to assess the relative performance with respect to these criteria.

6.1 INDIVIDUAL ANALYSIS OF SOIL REMEDIAL ALTERNATIVES

A discussion of individual analysis of each of the soil alternatives with respect to the evaluation criteria is provided in Section 6.1 of the Revised FS for Parcel D. Additional discussion of the soil remedial alternative is not provided in this addendum. Remedial alternatives that address radiologically-impacted soil sites in Parcel D are discussed in Section 6.5 below.

6.2 COMPARISON OF SOIL REMEDIAL ALTERNATIVES

A discussion comparing the five soil remedial alternatives is provided in Section 6.2 of the Revised FS for Parcel D. Additional discussion of the comparison of the soil remedial alternative is not provided in this addendum. Comparison of remedial alternatives that address radiologically-impacted soil sites in Parcel D is discussed in Section 6.6 below.

6.3 INDIVIDUAL ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

A discussion of individual analysis of groundwater alternatives with respect to the evaluation criteria is provided in Section 6.3 of the Revised FS for Parcel D. Alternatives GW-2, GW-3A, GW-3B, GW-4A, and GW-4B include monitoring for radionuclides. The inclusion of monitoring for radionuclides does not change the conclusions presented in Section 6.3 of the Revised FS for Parcel D. Therefore, no additional discussion of the groundwater alternatives is presented in this addendum. The groundwater monitoring will provide additional data to make informed discussions pertaining to potential risk.

6.4 COMPARISON OF GROUNDWATER REMEDIAL ALTERNATIVES

A discussion comparing the groundwater alternatives is provided in Section 6.4 of the Revised FS for Parcel D. Both alternatives include monitoring for radionuclides. The inclusion of monitoring for radionuclides does not change the conclusions presented in Section 6.4 of the Revised FS for Parcel D. Therefore, no additional discussion of the groundwater alternatives is presented in this addendum.

6.5 INDIVIDUAL ANALYSIS OF RADIOLOGICALLY-IMPACTED SITES REMEDIAL ALTERNATIVES

A discussion of individual analyses of each of the radiologically-impacted sites remedial alternatives, with respect to the evaluation criteria described in Section 6.0, is described in the following sections. A summary is presented in Table 6-1.

6.5.1 Individual Analysis of Alternative R-1

Under Alternative R-1, no remedial action would be taken. Radiologically-impacted sites would be left as is without implementing any institutional controls, containment, removal, or other mitigating actions. The no-action response is retained through the evaluation process as required by the NCP to provide a baseline for comparison with other alternatives. As discussed below, the overall rating of Alternative R-1 is not acceptable.

6.5.1.1 Overall Protection of Human Health and the Environment: Alternative R-1

ROCs at Parcel D pose unacceptable risks to human health under the proposed planned reuse for several redevelopment blocks. Alternative R-1 does not address these risks; therefore, the rating for Alternative R-1 for overall protection of human health and the environment is not protective.

6.5.1.2 Compliance with ARARs: Alternative R-1

There is no need to identify ARARs for the no-action alternative because ARARs apply to "any removal or remedial action conducted entirely on-site" and "no action" is not a removal or remedial action. CERCLA § 121 (42 United States Code § 9621) cleanup standards for selection of a Superfund remedy, including the requirement to meet ARARs, are not triggered by the no-action alternative (EPA, 1988). Therefore, a discussion of compliance with ARARs is not appropriate for this alternative.

6.5.1.3 Long-term Effectiveness and Permanence: Alternative R-1

The factors evaluated under long-term effectiveness and permanence included the magnitude of residual risks and the adequacy and reliability of the controls. Under the no-action alternative, residual soils contamination above remediation goals have not been addressed. No controls to prevent exposure and no long-term management measures such as institutional controls are implemented. Based on this evaluation, the overall rating for Alternative R-1 for long-term effectiveness and permanence is not protective.

6.5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative R-1

Alternative R-1 does not include treatment that would result in the destruction, transformation, or irreversible reduction in contaminant mobility. Therefore, the overall rating for Alternative R-1 for the reduction of toxicity, mobility, and volume through treatment is poor.

6.5.1.5 Short-term Effectiveness: Alternative R-1

Four factors are considered as part of the short-term effectiveness criteria and are assessed below for Alternative R-1.

No remedial actions would occur therefore the on-site community would not be exposed to additional risks. The off-site community would be protected, as radiologically-impacted sites that present unacceptable risk would not be disturbed.

No workers would be exposed to health risks during implementation of Alternative R-1 because no remedial action will be taken.

No adverse environmental impacts would result from construction and implementation of Alternative R-1 because no remedial action will be taken.

Because no remedial action will be taken, no time would be required to complete Alternative R-1. However, time is an inappropriate measure because no action is taken.

The overall rating for Alternative R-1 for short-term effectiveness is very good based on no additional risks or exposure as compared with current conditions.

6.5.1.6 Implementability: Alternative R-1

Implementability includes technical and administrative feasibility and the availability of required resources. No action, including implementing institutional controls or constructing and operating a remedial system, would be required to implement this alternative; therefore, Alternative R-1 would be very easily implemented, and the overall rating for Alternative R-1 for implementability is very good.

6.5.1.7 Cost: Alternative R-1

There are no costs associated with this alternative since no remedial activities would be performed. Therefore, the overall rating for Alternative R-1 for costs is excellent.

6.5.1.8 Overall Rating: Alternative R-1

Alternative R-1 is not acceptable because it fails to meet the threshold criteria and is not acceptable in terms of long-term effectiveness.

6.5.2 Individual Analysis of Alternative R-2

Alternative R-2 consists of decontamination of radiologically-impacted buildings and dismantlement if necessary. Surveys would be performed on buildings, soils of former building sites and outdoor areas, trenches resulting from sewer and storm line removal, soils of remediated storm drains, sanitary sewers, and outdoor areas to meet the remedial action objectives.

6.5.2.1 Overall Protection of Human Health and the Environment: Alternative R-2

Alternative R-2 provides protection to human health and the environment because it would remediate radiologically-impacted buildings, soils at former building sites, soils at the Gun Mole Pier and the NRDL Site on Mahan Street, storm drains, and sanitary sewers. No controls to prevent exposure and no long-term management measures such as institutional controls would need to be implemented. Therefore, the overall rating for Alternative R-2 for protection of human health and the environment is protective.

6.5.2.2 Compliance with ARARs: Alternative R-2

Alternative R-2 includes remedial actions. Both action- and chemical-specific ARARs associated with this alternative would be met. As a result, Alternative R-2 would meet ARARs.

6.5.2.3 Long-term Effectiveness and Permanence: Alternative R-2

The factors evaluated under long-term effectiveness and permanence included the magnitude of residual risks and the adequacy and reliability of the controls. Under Alternative R-2, radiologically-impacted soil in the Gun Mole Pier and NRDL Site on Mahan Street would be excavated and disposed of off site. Excavation would continue until results of confirmation samples indicate that RAOs are met. The long-term effectiveness and permanence in areas where soil is excavated is rated excellent.

Under Alterative R-2, radiologically-impacted buildings, soils of former building sites, trenches resulting from sewer and storm line removal, and soils from excavation of storm drains and sanitary sewers will be remediated and surveyed to verify that the RAOs are met. The long-term effectiveness permanence is rated excellent. The overall rating for Alternative R-2 for long-term effectiveness and permanence is very good.

6.5.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative R-2

Alterative R-2 includes excavation of radiologically-impacted soil and remediation of radiologically-impacted building materials. These remedial activities do not include treatment that would result in the destruction, transformation, or irreversible reduction in contamination mobility. Therefore, Alternative R-2 rating for reduction of toxicity, mobility, or volume is poor.

6.5.2.5 Short-term Effectiveness: Alternative R-2

Four factors are considered as part of the short-term effectiveness criteria and are assessed below for Alternative R-2.

The on-site and off-site community would be protected by containment controls such as dust suppression during scabbling, demolition, and removal of ROCs.

Workers would be protected during ROC remediation from Parcel D-impacted sites by implementing containment controls such as dust suppression and following health and safety protocols, including personal protective equipment and decontamination procedures.

The estimated time required to implement Alternative R-2 is less than one year, and the effects of implementing this alternative would be nearly immediate.

The overall rating for alternative R-2 for short-term effectiveness is very good.

6.5.2.6 Implementability: Alternative R-2

Implementability includes technical and administrative feasibility and the availability of required resources. The alternative is technically feasible and easily implemented since the action can be readily implemented using widely available commercial services, materials, and equipment. The overall rating for implementability is very good.

6.5.2.7 Cost: Alternative R-2

The cost estimate for Alternative R-2 was generated based on data collected from site information, dated drawings, and engineering estimates. The estimated cost for Alternative R-2 is rated as good.

Appendix B of this addendum provides a detailed description of the Alternative R-2 cost estimate and associated assumptions and limitations.

6.5.2.8 Overall Rating: Alternative R-2

Alternative R-2 is protective of human health and the environment, meets ARARs, is effective in the short and long term, and is easily implemented, but is costly. The overall rating for this alternative is good.

6.6 COMPARISON OF RADIOLOGICALLY-IMPACTED SITE REMEDIAL ALTERNATIVES

This section compares the two radiologically-impacted sites' remedial alternatives. The discussion of each evaluation criterion generally proceeds from the alternative that best satisfies the criterion to the one that least satisfies the criterion. Table 6-1 summarizes the ratings for each alternative and shows a comparison of the ratings for each alternative for the two threshold and five balancing NCP evaluation criteria.

6.6.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is a threshold criterion. Protection is not measured by degree; rather, each alternative is considered as either protective or not protective. Alternative R-2 is protective. This alternative is protective because it includes remediation that reduces exposure to ROCs. Alternative R-1 does not address any risk at the site and hence does not provide any protection to human health and the environment.

6.6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs is a threshold evaluation criterion. An alternative must either comply with ARARs or justification must be provided for a waiver. Alternative R-2 fulfills all the pertinent ARARs. Alternative R-1 does not meet the ARARs.

6.6.3 Long-term Effectiveness and Performance

Alternative R-2 provides very good long-term effectiveness and performance for radiologically-impacted sites. Alternative R-1 will have very little long-term effectiveness and performance because it includes no action.

6.6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives R-1 and R-2 rate equally poorly because they do not include treatment that would result in the destruction, transformation, or irreversible reduction in ROC mobility.

6.6.5 Short-term Effectiveness

Alternative R-1 has the least effect on the community, remedial workers, or the environment because it includes no actions and therefore would not disturb the ROCs. Alternative R-2 includes removing and hauling contaminated soil. This would pose a potential risk to the community, remedial workers, or the environment, although this risk is considered low and mitigation measures would be implemented.

6.6.6 Implementability

Distinction among the alternatives for implementability is minimal. Alternative R-2 requires the utilization of standard technologies that are easy to implement. Alternative R-1 does not involve remedial technologies and requires no implementation.

6.6.7 Cost

Alternative R-1 requires no action; therefore, no costs are associated with this alternative. Alterative R-2 is costly but does address all radiologically-impacted sites.

6.6.8 Overall Rating of Impacted Building Alternatives

An overall rating was assigned to each alternative. Alterative R-2 is rated very good overall for the two threshold and five balancing NCP evaluation criteria. Alternative R-1 is rated as not acceptable.

6.7 CONCLUSION

Section 6.5 of the Revised FS for Parcel D summarizes the rationale for re-evaluating the current remedy based on the updated information about the site and subsequent revisions to the conceptual site model.

Radiological contamination was not addressed by the record of decision; however, radiological contamination is present at Parcel D. This radiological addendum to the Revised FS for Parcel D was prepared to evaluate remediation alternatives for radiological contamination.

The final soil remedy for Parcel D will be a combination of alternatives presented in the Revised FS for Parcel D and the alternative presented in this addendum for soil. The groundwater remedy will be an alterative presented in the Revised FS for Parcel D with the addition of groundwater monitoring for ROCs. The remedy for radiologically-impacted structures in Parcel D is addressed by the alternative presented in this addendum.

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TABLES

TABLE 2-1

PARCEL D IMPACTED AREAS, RADIONUCLIDES OF CONCERN, HISTORICAL USES, AND PLANNED REUSE

Building Number or Area Title	Radionuclides of Concern	Building or Area Use	Redevelopment Block Planned Reuse
274	strontium-90, cesium-137, radium-226	Decontamination training and office space	Maritime – Industrial
313 Site	strontium-90, cesium-137, radium-226, thorium-232, plutonium-239	NRDL Instrumentation Laboratory, stockroom, and storage	Maritime – Industrial
313A Site	strontium-90, cesium-137, radium-226, thorium-232, plutonium-239	Laboratory offices, training, and storage	Maritime – Industrial
317 Site	strontium-90, cesium-137, radium-226	Temporary animal quarters for NRDL	Open Space
322 Site	strontium-90, cesium-137, radium-226, thorium-232, plutonium-239	NRDL offices, instruments branch, field office when in Parcel A	Maritime – Industrial
351	strontium-90, cesium-137, radium-226, thorium-232	Electronic work area/shop, optical laboratories, NRDL Material and Accounts division, NRDL Technical Information Division, BUMED storeroom, NRDL Office Services Branch, NRDL Thermal Branch, machine shop (on first floor), NRDL Engineering Division, NRDL library, sampling laboratory, general research laboratories, and biological research laboratories	Open Space
351A	strontium-90, cesium-137, radium-226, thorium-232, plutonium-239	NRDL Chemical Technology Division, NRDL Applied Research Branch, NRDL Chemical Technology Division, NRDL administrative offices, NRDL Nuclear and Physical Chemistry Branch, NRDL Chemical and Physics Branch, NRDL Analytical and Standards Branch, instrument repair facility, metrology laboratory,	Open Space

TABLE 2-1

PARCEL D IMPACTED AREAS, RADIONUCLIDES OF CONCERN, HISTORICAL USES, AND PLANNED REUSE

Building Number or Area Title	Radionuclides of Concern	Building or Area Use	Redevelopment Block Planned Reuse
		electronics shop annex, material storage area, instrument calibration laboratory, and radiography shop	
364	cobalt-60, strontium-90, cesium-137, radium-226, uranium-235, plutonium-239	Animal irradiation facility, liquid radioactive waste collection facility, hot cell, Research Animal Facility, storage building, isotope processing and decontamination studies, and general research laboratory. Formerly leased by Young Laboratories	Open Space
365	strontium-90, cesium-137, radium-226, uranium-235, plutonium-239	Personnel decontamination facility, change house, storage, and NRDL small animal facility	Open Space
366/351B	strontium-90, cesium-137, radium-226	NRDL instrument calibration, administrative offices, Applied Research and Technical Development Branches; administrative offices moved from D-19, 20, and 21 in 1952; Radiological Safety Branch; Management Planning Division; Nucleonics Division; Instruments Evaluation Section; general laboratories; Chemical Research Laboratory; shipyard radiography shop; Boat/Plastic Shop;other military/Navy Branch Project Officers Station; and NRDL Management Engineering and Comptroller Department	Open Space
383 Area	hydrogen-3, strontium-90, radium-226	Turn-in area for radium devices removed from ships before this building was constructed	Maritime – Industrial
401	No report in HRA (2004)		Mixed Use
408	radium-226, natural thorium	Furnace smelter	Industrial

TABLE 2-1

PARCEL D IMPACTED AREAS, RADIONUCLIDES OF CONCERN, HISTORICAL USES, AND PLANNED REUSE

Building Number or Area Title	Radionuclides of Concern	Building or Area Use	Redevelopment Block Planned Reuse
411	cobalt-60, cesium-137, radium-226	Source storage, civilian cafeteria, radiography shop, Shipfitters and Boilermakers Shop, and Ship Repair Shop	Industrial
813	strontium-90	General warehouse and offices, supply storehouse, and Disaster Control Center	Mixed Use
819	cesium-137, radium-226	Sewer Pump Station A	Mixed Use
Gun Mole Pier	strontium-90, cesium-137, radium-226, plutonium-239	Radioactive pavement decontamination study, decontamination studies on NRDL Experimental Barge YFN-809 and on a contaminated B-17 aircraft, landing area for NRDL Barge YFNX-16, and used as a decontamination and laboratory facility. Decontamination facilities were also in a structure near Barge YFNX-16. The ex-INDEPENDENCE was berthed at the Gun Mole Pier and it was a loading point for radioactive wastes. An ocean disposal barge was also loaded from the Gun Mole Pier	Maritime – Industrial
NRDL Site on Mahan Street	strontium-90, cesium-137, radium-226, plutonium-239	Potential storage site of OPERATION CROSSROADS material.	Maritime – Industrial
Sanitary Sewers	strontium-90, cesium-137, radium-226	Sanitary Sewer System	Industrial, Maritime – Industrial, Mixed Use, Research and Development
Storm Drains	strontium-90, cesium-137, radium-226	Combined Storm and Sanitary Sewer Drains. Due to the nature of the separation process, radiological contamination from the same source could have impacted the piping and other components of both systems	Industrial, Maritime – Industrial, Mixed Use, Research and Development

Abbreviations and Acronyms:

BUMED – Navy Bureau of Medicine and Surgery
HRA – Historical Radiological Assessment
NRDL – Naval Radiological Defense Laboratory

TABLE 2-2

LIST OF RADIONUCLIDES, HALF-LIVES, AND RADIATIONS EMITTED

Radionuclide	Half-life	Radiations Released When Decayed
cesium-137	30 years	Beta particle, gamma ray
cobalt-60	5.3 years	Beta particle, gamma rays
plutonium-239	24,100 years	Alpha particle, x-rays
radium-226	1,600 years	Alpha and beta particles, and gamma rays
strontium-90	29.1 years	Beta particles
thorium-232	14,100,000,000 years	Alpha particle, gamma rays
hydrogen-3	12.35 years	Beta particle
uranium-235	70,400,000 years	Alpha particle, x-rays

TABLE 2-3

PARCEL D BUILDING/AREA ASSESSMENT AND CLASSIFICATION

Building No. or Area	Contamination Potential					Contaminated Media								Potential Migration Pathways							
	Known-restricted Access	Known-continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Sediment	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Sediment	Surface Water	Groundwater	Air	Structures	Drainage System
274				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N
313 Site			✓			L	L	N	N	N	N	N	N	L	L	N	N	N	N	N	N
313A Site			✓			M	L	M	N	N	N	N	M	L	L	L	N	N	N	N	L
317 Site			✓			L	L	N	N	N	N	N	N	L	L	N	N	N	N	N	N
322 Site			✓			L	N	N	N	N	N	N	N	L	N	N	N	N	N	N	N
351			✓			N	N	L	N	N	N	M	L	N	N	L	N	N	N	L	L
351A		✓				M	M	M	N	N	N	M	M	M	M	L	N	N	N	L	L
364	✓					H	M	H	N	N	N	H	H	M	L	M	N	N	N	M	M
365				✓		N	N	L	N	N	N	L	L	N	N	L	N	N	N	L	L
366/351B		✓				N	N	M	N	N	N	M	M	N	N	L	N	N	N	L	L
383 Area				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N
401					✓	N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N
408			✓			N	N	N	N	N	N	M	N	N	N	N	N	N	N	L	N
411				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N
813				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N
819			✓			N	L	M	N	N	N	L	M	N	L	M	N	N	N	L	M
Gun Mole (Regunning) Pier			✓			L	L	L	N	N	N	L	L	L	L	L	N	N	N	L	L

TABLE 2-3

PARCEL D BUILDING/AREA ASSESSMENT AND CLASSIFICATION

Building No. or Area	Contamination Potential					Contaminated Media								Potential Migration Pathways							
	Known-restricted Access	Known-continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Sediment	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Sediment	Surface Water	Groundwater	Air	Structures	Drainage System
NRDL Site on Mahan Street			✓			M	M	N	N	N	N	N	N	L	L	N	N	N	N	N	N
Storm Drains	✓					L	M	H	L	L	N	M	H	L	L	M	L	L	N	L	M
Sanitary Sewers	✓					N	M	H	N	N	N	L	H	N	L	M	N	N	N	L	M

Abbreviations and Acronyms:

- H — High – Evidence of contamination in the media or migration pathway has been identified.
- M — Moderate – The potential for contamination in the media or migration pathway exists, although the extent has not been fully assessed.
- L — Low – The potential for contamination in the type of media or migration pathway is remote.
- N — None – Evidence of contamination in the specific media or migration pathway has not been found, or known contamination has been removed, and surveys indicate that the media or migration pathway meets today's release criteria.

TABLE 3-1

PARCEL D BUILDINGS, FORMER BUILDING SITES, AND FILL AREAS ALONG WITH THEIR REDEVELOPMENT BLOCKS, PLANNED REUSE, AND REUSE SCENARIOS

Building/ Site Number	Redevelopment Block	Redevelopment Block Planned Reuse	Reuse Scenario
274	DMI-1	Maritime-Industrial	Industrial
313 Site	DMI-1	Maritime-Industrial	Industrial
313A Site	DMI-1	Maritime-Industrial	Industrial
317 Site	39	Open Space	Recreational
322 Site	DMI-1	Maritime-Industrial	Industrial
351	39	Open Space	Recreational
351A	39	Open Space	Recreational
364	39	Open Space	Recreational
365	39	Open Space	Recreational
366/351B	39	Open Space	Recreational
383 Area	DMI-1	Maritime-Industrial	Industrial
401	30A	Mixed Use	Residential
408	38	Industrial	Industrial
411	38	Industrial	Industrial
813	A	Research and Development	Residential
819	A	Research and Development	Residential
NRDL Site on Mahan Street	DMI-1	Maritime-Industrial	Industrial
Gun Mole Pier	DMI-1	Maritime-Industrial	Industrial
Storm Drains	All Blocks	Industrial, Maritime-Industrial, Mixed Use, Research and Development, Open Space	Residential, Industrial, and Recreational
Sanitary Sewers	All Blocks	Industrial, Maritime-Industrial, Mixed Use, Research and Development, Open Space	Residential, Industrial, and Recreational

Abbreviations and Acronyms:

NRDL – Naval Radiological Defense Laboratory

TABLE 3-2

REMEDIATION GOALS

Radionuclide	Surfaces[f] (dpm/100 cm²)		Soil[c f] (pCi/g)		Water [f] (pCi./L)
	Equipment, Waste[a] (dpm/100 cm²)	Structures[b] (dpm/100 cm²)	Construction Worker	Residential	
cesium-137	5,000	5,000	0.113	0.113	119
cobalt-60	5,000	5,000	0.0602	0.0361	100
plutonium-239	100	100	14.0	2.59	15
radium-226	100	100	1.0[d]	1.0[d]	5.0[e]
strontium-90	1,000	1,000	10.8	0.331	8
thorium-232	1,000	36.5	19.0	1.69	15
hydrogen-3	5,000	5,000	4.23	2.28	20,000
uranium-235	5,000	488	0.398	0.195	30

Notes:

[a] These limits are based on AEC *Regulatory Guide 1.86* (1974). Limits for removable surface activity are 20 percent of these values.

[b] These limits are based on 25 mrem/y, using DandD Version 2 or *Regulatory Guide 1.86*, whichever is lower.

[c] EPA PRGs for two future-use scenarios.

[d] Limit is 1 pCi/g above background; not to exceed 2 pCi/g total, per agreement with EPA.

[e] Limit is for total radium concentration.

[f] Taken from *Revised Final Basewide Radiological Removal Action, Action Memorandum.* Hunters Point Shipyard, San Francisco, California. February 14.

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm² – square centimeter
dpm – disintegration per minute
EPA – U.S. Environmental Protection Agency
MDA – minimum detectable activity
mrem/y – millirem per year
pCi/g – picocurie per gram
PRG – Preliminary Remediation Goal

TABLE 3-3

RESRAD-BUILD RESULTS[a]

Parcel D Impacted Sites	Radiological Risk[b]	Dose[c]
Building 274	3.46×10^{-6}	3.57
Building 351	4.17×10^{-6}	28.5
Building 351A	4.73×10^{-6}	32.9
Building 366/351B	3.46×10^{-6}	3.57
Building 401	1.34×10^{-6}	0.644
Building 411	9.26×10^{-6}	11.0
Building 813	2.77×10^{-7}	0.69
Building 819	3.18×10^{-6}	2.89

Abbreviations and Acronyms:

[a] Total risk and dose is equivalent to incremental risk and dose
[b] Total excess lifetime carcinogen risk
[c] millirem per year

TABLE 3-4

RESRAD RESULTS

TOTAL DOSE AND RISK		
Impacted Soil Areas	**Radiological Risk[a]**	**Dose[b]**
313 Site	1.02×10^{-4}	4.66
313A Site	8.90×10^{-5}	4.04
317 Site	6.37×10^{-5}	2.93
322 Site	9.07×10^{-5}	4.11
364 Site	3.17×10^{-5}	1.50
365 Site	3.60×10^{-5}	1.67
383 Site	6.52×10^{-5}	2.98
408 Site	2.43×10^{-4}	11.0
Gun Mole Pier	5.08×10^{-5}	2.40
Naval Radiological Defense Laboratory Site on Mahan Street	5.08×10^{-5}	2.40
Sanitary Sewers/Storm Drains	6.75×10^{-5}	3.09
Incremental Dose and Risk		
Impacted Soil Areas	**Radiological Risk[a]**	**Dose[b]**
313 Site	8.97×10^{-5}	4.08
313A Site	7.80×10^{-5}	3.54
317 Site	4.28×10^{-5}	1.97
322 Site	7.95×10^{-5}	3.60
364 Site	2.15×10^{-5}	1.04
365 Site	2.43×10^{-5}	1.13
383 Site	4.35×10^{-5}	1.98
408 Site	2.13×10^{-4}	9.60
Gun Mole Pier	3.42×10^{-5}	1.64
Naval Radiological Defense Laboratory Site on Mahan Street	3.42×10^{-5}	1.64
Sanitary Sewers/Storm Drains	4.54×10^{-5}	2.08

Notes:

a Total excess lifetime carcinogen risk

b mrem/yr

Abbreviations and Acronyms:

Mem/yr – millirem per year
NRDL – Naval Radiological Defense Laboratory

TABLE 3-5

COMBINED TOTAL RISK FROM CHEMICAL AND RADIOLOGICAL RISKS

Parcel D Impacted Sites	Radiological Risk[b]	Chemical Risk[a,b]	Redevelpment Block	Parcel D Grid(s)	Risk Combination Results
Building 274	3.46×10^{-6}	2.00×10^{-5}	DMI-1	BA22	2.35×10^{-5}
Building 313 Site	1.02×10^{-4}	3.00×10^{-6}	DMI-1	BA21	1.05×10^{-4}
Building 313A Site	8.90×10^{-5}	3.00×10^{-6}	DMI-1	BA21	9.20×10^{-5}
Building 317 Site	6.37×10^{-5}	1.00×10^{-4}	39	AY23	1.64×10^{-4}
Building 322 Site	9.07×10^{-5}	Not Evaluated	DMI-1	AZ21	9.07×10^{-5}
Building 351	4.17×10^{-6}	1.00×10^{-5}	39	AW23	1.42×10^{-5}
Building 351A	4.73×10^{-6}	3.00×10^{-6}	39	AX24	7.73×10^{-6}
Building 364 Site	3.17×10^{-5}	1.00×10^{-4}	39	AY23	1.32×10^{-4}
Building 365 Site	3.60×10^{-5}	3.00×10^{-6}	39	AY24	3.90×10^{-5}
Building 366/351B	3.46×10^{-6}	1.00×10^{-5}	39	AW20, AW21, AX21	1.35×10^{-5}
Building 383 Area	6.52×10^{-5}	1.00×10^{-5}	DMI-1	BH23, BH24	7.52×10^{-5}
Building 401	1.34×10^{-6}	8.00×10^{-6}	30A	AR24	9.34×10^{-6}
Building 408 Site	2.43×10^{-4}	5.00×10^{-6}	38	AY27	2.48×10^{-4}
Building 411	9.26×10^{-6}	2.00×10^{-5}	38	AU24, AV25	2.93×10^{-5}
Building 813	2.77×10^{-7}	5.00×10^{-6}	A		5.28×10^{-6}
Building 819	3.18×10^{-6}	5.00×10^{-6}	A		8.18×10^{-6}
Gun Mole Pier	5.08×10^{-5}	3.00×10^{-5}	DMI-1	BB25, BL24	8.08×10^{-5}
NRDL Site on Mahan Street	5.08×10^{-5}	2.00×10^{-5}	DMI-1	BE27	7.08×10^{-5}
Sanitary Sewers	6.75×10^{-5}	1.00×10^{-4}	All Blocks	AY-23	1.68×10^{-4}
Storm Drains	6.75×10^{-5}	1.00×10^{-4}	All Blocks	AY-23	1.68×10^{-4}

Notes:

[a] Chemical risk was taken from Revised FS for Parcel D, Tables B-15 and B-16.
[b] Excess lifetime carcinogen risk

Abbreviations and Acronyms:

NRDL – Naval Radiological Defense Laboratory

TABLE 3-6

COMBINED INCREMENTAL RISK FROM CHEMICAL AND RADIOLOGICAL RISKS

Parcel D Impacted Sites	Radiological Risk[b]	Chemical Risk[a,b]	Redevelpment Block	Parcel D Grid(s)	Risk Combination Results
Building 274	3.46×10^{-6}	4.00×10^{-8}	DMI-1	BB22	3.50×10^{-6}
Building 313 Site	8.97×10^{-5}	6.00×10^{-7}	DMI-1	BA21	9.03×10^{-5}
Building 313A Site	7.80×10^{-5}	6.00×10^{-7}	DMI-1	BA21	7.86×10^{-5}
Building 317 Site	4.28×10^{-5}	1.00×10^{-4}	39	AY23	1.43×10^{-4}
Building 322 Site	7.95×10^{-5}	Not Evaluated	DMI-1	AZ21	7.95×10^{-5}
Building 351	4.17×10^{-6}	1.00×10^{-7}	39	AW23	4.27×10^{-6}
Building 351A	4.73×10^{-6}	1.00×10^{-4}	39	AY23	4.83×10^{-6}
Building 364 Site	2.15×10^{-5}	1.00×10^{-4}	39	AY23	1.22×10^{-4}
Building 365 Site	2.43×10^{-5}	3.00×10^{-8}	39	AY24	2.43×10^{-5}
Building 366/351B Site	3.46×10^{-6}	Not Evaluated	39	AV22	3.46×10^{-6}
Building 383	4.35×10^{-5}	2.00×10^{-6}	DMI-1	BH23	4.55×10^{-5}
Building 401	1.34×10^{-6}	Not Evaluated	30A	AQ23	1.34×10^{-6}
Building 408 Site	2.13×10^{-4}	Not Evaluated	38	AX27	2.13×10^{-4}
Building 411	9.26×10^{-6}	1.00×10^{-6}	38	AW25	1.03×10^{-5}
Building 813	2.77×10^{-7}	5.00×10^{-6}	A		5.28×10^{-6}
Building 819	3.18×10^{-6}	5.00×10^{-6}	A		8.18×10^{-6}
Gun Mole Pier	3.42×10^{-5}	3.00×10^{-5}	DMI-1	BB24, BL24	6.42×10^{-5}
NRDL Site on Mahan Street	3.42×10^{-5}	Not Evaluated	DMI-1	BE27, BF27	3.42×10^{-5}
Sanitary Sewers	4.54×10^{-5}	1.00×10^{-4}	All Blocks	AY23	1.45×10^{-4}
Storm Drains	4.54×10^{-5}	1.00×10^{-4}	All Blocks	AY23	1.45×10^{-4}

Notes:

[a] Chemical risk was taken from Revised FS for Parcel D, Tables B-19 and B-20.
[b] Excess lifetime carcinogen risk

Abbreviations and Acronyms:

NRDL – Naval Radiological Defense Laboratory

TABLE 4-1

POTENTIAL FEDERAL AND STATE ARARs TO BE CONSIDERED CRITERIA FOR POTENTIALLY CONTAMINATED SITES AT HPS

Regulation	Requirement	Citation[b]	ARAR Determination	Comments
Chemical-specific[a] ARAR				
Health and Environmental Standards for Drinking Water	MCLs for radionuclides Combined ^{226}Ra and ^{228}Ra - 5 pCi/L Gross alpha (including ^{226}Ra but excluding radon and uranium) - 15 pCi/L ^{3}H - 20,000 pCi/L ^{90}Sr – 8 pCi/L Beta and photon – 4 mrem/y Uranium – 30 μg/L	40 C.F.R., § 141.66	Not an ARAR	This requirement is not an ARAR since groundwater is not a medium of concern.
Radiological Criteria for Unrestricted Use at Closing NRC Licensed Facilities	A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem/y, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to ALARA.	10 C.F.R., § 20.1402	Relevant and Appropriate	This ARAR is not applicable because Parcel D is not an NRC-licensed radiologically contaminated site. This ARAR is potentially relevant and appropriate for an unrestricted land-use scenario.
Radiological Criteria for License Termination Under Restricted Conditions	As a condition for license termination with restricted site use, the licensee must demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of 10 C.F.R., § 20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA.	10 C.F.R., § 20.1403(a)	Not an ARAR	This requirement is not an ARAR because Parcel D is not an NRC-licensed radiologically contaminated site nor will radioactive materials be left on-site
Radiological Criteria for License Termination Under Restricted Conditions	As a condition for license termination with restricted site use, the licensee must make provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/y.	10 C.F.R., § 20.1403(b)	Not an ARAR	This requirement is not an ARAR because Parcel D is not an NRC-licensed radiologically contaminated site and will not have a restricted release since no

TABLE 4-1

POTENTIAL FEDERAL AND STATE ARARs TO BE CONSIDERED CRITERIA FOR POTENTIALLY CONTAMINATED SITES AT HPS

Regulation	Requirement	Citation[b]	ARAR Determination	Comments
				waste may be left on site.
Alternative Radiological Criteria for License Termination	Alternative criteria are allowed for license termination as long as assurance is provided that public health and safety would continue to be protected and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 100 mrem/y limit of subpart D, by submitting an analysis of possible sources of exposure; to the extent that practical restrictions for on-site use are employed according to the provisions of § 20.1403 in minimizing exposures at the site; and doses are reduced to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal.	10 C.F.R., § 20.1404(a)(1)-(a)(3)	Not an ARAR	Not applicable because Parcel D is not an NCR-regulated site. This ARAR is not an ARAR since no ALARA analysis has been documented and the calculated dose is less than 25 mrem/y.
Dose Limits for Individual Members of the Public	Requires that the TEDE to individual members of public not exceed 0.1 rem from licensed operation: construction, operation, and decommissioning of commercial reactors and fuel cycle facilities; possession, use, processing, exporting, and certain aspects of transporting nuclear materials and waste; and siting, design, construction, operations, and closure of waste disposal sites.	10 C.F.R., § 20.1301(a)(1)	Not an ARAR	This ARAR is not applicable because Parcel D is not an NRC-licensed radiologically contaminated site, nor will radioactive materials be left onsite in a waste disposal or otherwise regulated facility.
ALIs and DACs of Radionuclides for Occupational Exposures	Establishes limits for effluent releases to unrestricted area particularly in the implementation of the provisions of § 20.1302, which implement the radiation dose limits for the public as listed in § 20.1301.	10 C.F.R., § 20, Appendix B, Table 2	Relevant and Appropriate	This requirement is applicable to all removal actions performed in proximity to San Francisco Bay.
Location-specific ARAR				
Federal Coastal Zone Management Act	This act specifies that federal actions that affect the coastal zone must be consistent with the policies of the San Francisco Bay Conservation and Development Commission's federally approved coastal management program.	16 U.S.C. 1456(c)(1)(A)	Applicable	This requirement is applicable to all removal actions performed in proximity to San Francisco

TABLE 4-1

POTENTIAL FEDERAL AND STATE ARARs TO BE CONSIDERED CRITERIA FOR POTENTIALLY CONTAMINATED SITES AT HPS

Regulation	Requirement	Citation[b]	ARAR Determination	Comments
				Bay.
Action-specific ARAR				
Protection of the General Population from Releases of Radioactivity	Performance objectives for the land disposal of LLRW. Concentrations of radioactive material that may be released into the general environment must not result in an annual dose exceeding 25 mrem/y to the body or any organ of the general public.	10 C.F.R., § 61.41	Not an ARAR	This requirement is not an ARAR since no radioactive materials will remain on site.
Protection from Inadvertent Intrusion	Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.	10 C.F.R., § 61.42	Not an ARAR	This requirement is not an ARAR since no radioactive materials will remain on site
Protection of the Individuals During Operations	Every reasonable effort shall be made to maintain radiation exposures ALARA.	10 C.F.R., § 61.43	Not an ARAR	This requirement is not an ARAR since no radioactive materials will remain on site
Stability of the Disposal Site After Closure	The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.	10 C.F.R., § 61.44	Not an ARAR	This requirement is not an ARAR since no radioactive materials will remain on site.
Waste Disposal by Release into Sanitary Sewage	A licensee may discharge licensed material into sanitary sewer if each of the following conditions is satisfied: the material is readily soluble in water; and the quantity that the licensee releases into the sewer in 1 month divided by the average monthly volume of water released does not exceed the concentration listed in Table 3 of Appendix B to Part 20 represented by discharges into sanitary sewer by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the	10 C.F.R., § 20.2003	Not an ARAR	Not applicable since Parcel D is not an NRC- regulated site. Not potentially relevant and appropriate because radioactive waste will not be discharged to sanitary sewer.

TABLE 4-1

POTENTIAL FEDERAL AND STATE ARARs TO BE CONSIDERED CRITERIA FOR POTENTIALLY CONTAMINATED SITES AT HPS

Regulation	Requirement	Citation[b]	ARAR Determination	Comments
	concentration of that radionuclide listed in Table 3 of Appendix B to Part 20; and the sum of the fractions for each radionuclide required by paragraph (a)(3)(i) of this section does not exceed unity; and the total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 5 Ci of ^{3}H, 1 Ci of ^{14}C, and 1 Ci of all other radioactive materials combined.			
	A licensee may treat or dispose of licensed material by incineration only: as authorized by paragraph (b) of this section; or if the material is in a form and concentration specified in § 20.2005. Waste oils that have been radioactively contaminated in the course of the operation or maintenance of a nuclear power reactor may be incinerated on the site where generated provided that the total radioactive effluents from the facility, including the effluents from such incineration, conform to the requirements of Appendix I to § 50 of this chapter and the effluent release limits contained in applicable license conditions other than effluent limits specifically related to incineration of waste oil. Solid residues produced in the process of incinerating waste oils must be disposed of as provided by § 20.2001.	10 CFR § 20.2004(a)	Not an ARAR	Not applicable since Parcel D is not an NRC-regulated site. Not potentially relevant and appropriate for sites containing radioactive waste since the waste will not be incinerated.

Notes:

[a] Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables.
[b] Only the substantive provisions of the requirements cited in this table are potential ARARs.

Abbreviations and Acronyms:

μg/L – microgram per liter
ALARA – as low as reasonable achievable
ALI – Annual Limit of Intake
ARAR – applicable or relevant and appropriate requirement
^{14}C – carbon-14
C.F.R. – Code of Federal Regulations
Ci – curie
DAC – derived airborne concentration
DON – Department of the Navy
^{3}H – hydrogen-3

TABLE 4-1

POTENTIAL FEDERAL AND STATE ARARs TO BE CONSIDERED CRITERIA FOR POTENTIALLY CONTAMINATED SITES AT HPS

HPS – Hunters Point Shipyard
LLRW – low-level radioactive waste
mrem/y – millirem per year
NRC – Nuclear Regulatory Commission
pCi/L – picocurie per liter
^{226}Ra – radium-226
^{228}Ra – radium-228
^{90}Sr – strontium-90
TEDE – total effective dose equivalent
U.S.C. – United States Code

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
SOIL							
No Action	Not Applicable	Not Applicable	No Action	Does not achieve RAOs.	Not acceptable to local government or public.	None	**Retained** – required by NCP.
Institutional Controls	Institutional Controls	Institutional Controls	Fencing, barriers, and posting signs to restrict land use where there is exposure to potentially chemically contaminated soil. Prohibits activities not specified for the designated land use; prohibits growing produce in native soil. Restricts the use of the parcel to those re-uses that are identified at the time the ROD amendment is signed; includes criteria during and after future development to assure that mitigated exposure conditions are maintained such as covers, barriers, or other engineering controls.	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination.	Requires legal documents and authority to enforce restrictions, Easily implemented.	Low Cost	**Retained** – easily implemented and effective, usually required to restrict activity based on land use.
Removal	Excavation	Conventional excavation	Excavation of contaminants, soil and materials with the ROC concentration above RAOs.	Effective at removing contamination and preventing long-term exposure to contamination; may expose workers and	Easily implemented for defined areas of contamination; easily implemented for ROCs; may need	Moderate cost (based on previous excavations)	**Retained** – effective for ROCs and quickly implemented; moderate cost.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				environment to contaminants during implementation; uses conventional construction methods; proven technology.	to excavate to 10 feet bgs.		
	Off-site Disposal	Disposal of excavated radioactively contaminated soil and material into a facility licensed to receive low-level radioactive waste.	Transport and dispose of soils at a permitted treatment and disposal facility.	Effective at preventing exposure of receptors to contamination; does not reduce total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method.	Requires appropriate transportation permits and waste characterization. Easily implemented.	High cost	**Retained** – effective; easily and quickly implemented; permanent remedy; high cost.
Containment	Covers	Soil, Asphalt, or Concrete Cover	Placement of a soil, asphalt, or concrete cover over contaminated soil, prevents contact with contamination.	Effective at preventing exposure of receptors to contamination, must be used with land-use controls to maintain protectiveness, susceptible to weathering and cracking.	Paved areas can be easily maintained using conventional methods; soil or asphalt cover could be used in areas currently unpaved. Easily implemented.	Moderate cost	**Retained** – for areas that are paved or require paving to achieve planned land uses; can be used with a soil cover.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
		Manual screening	Manual screening of excavated soil and material to separate the soil and material exceeding the cleanup standard from the soil below the cleanup standard. This may be accomplished by soil sampling and analyses in the field.	Effective at preventing exposure of receptors to contamination; reduces the total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method.	Requires appropriate equipment, instrumentation, and trained personnel.	High cost	**Retained** – for fill areas that need to be excavated.
Containment	Covers	Soil, Asphalt, or Concrete Cover	Placement of a soil, asphalt, or concrete cover over contaminated soil, prevents contact with contamination.	Effective at preventing exposure of receptors to contamination, must be used with land-use controls to maintain protectiveness, susceptible to weathering and cracking.	Paved areas can be easily maintained using conventional methods; soil or asphalt cover could be used in areas currently unpaved. Easily implemented.	Moderate cost	**Retained** – for areas that are paved or require paving to achieve planned land uses; can be used with a soil cover.
		Manual screening	Manual screening of excavated soil and material to separate the soil and material exceeding the cleanup standard from the soil below the cleanup standard. This may be accomplished by soil sampling and analyses in the field.	Effective at preventing exposure of receptors to contamination; reduces the total amount of contamination; may expose workers and environment to contaminants during	Requires appropriate equipment, instrumentation, and trained personnel.	High cost	**Retained** – for fill areas that need to be excavated.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				implementation; conventional method.			
GROUNDWATER							
No action	Not Applicable	Not Applicable	No Action	Not effective	Easy to implement.	Not Applicable.	**Retained** – required by NCP.
Institutional Controls	Institutional Controls	Institutional Controls	Prohibits activities that could spread groundwater contamination by requiring locked well caps and secured utility access covers and requiring identifying and securing any additional conduit where potential receptors could be exposed to the groundwater; requires posted signs and locked doors to prohibit occupancy of existing buildings or other enclosures where there is unacceptable risk from the vapor intrusion pathway; requires vapor barriers for new construction in areas of unacceptable risk. Prohibits extraction and use of groundwater at the site, except actions performed in accordance with site health and safety requirements; allows only designated land use in accordance	Effective as long as institutional controls are in effect.	Easy to implement.	Low cost	**Retained** – easily implemented and effective; prevents exposure to ROCs.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
			with the proposed redevelopment plan. Prohibits certain type of construction and development based on designated land use, and must be in accordance with the land use restrictions; includes criteria during and after development to assure that mitigated exposure conditions to groundwater and to VOCs from the vapor intrusion pathway are maintained or modified for continued protection for the receptors.				
Treatment	Passive	Natural recovery	ROCs are allowed to naturally attenuate via decay, dispersion, dilution, or adsorption; requires monitoring to assess recovery rates and success.	Effective for all ROCs at low concentrations.	Easily implemented.	Low cost	**Retained** – but slow results

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
	Ex-Situ Pump and Treat	Chemical, physical, or biological treatment	Vertical or horizontal wells are pumped to extract contaminated groundwater from the saturated zone; extracted groundwater is treated through chemical, physical, or biological processes; treated water is released to the surface, to surface water, or to a wastewater treatment plant or is re-injected	Not effective for all chemicals and not effective for ROCs.	Not effective for ROCs.	High O & M cost.	**Eliminated -** not effective for ROCs.
		Dual Phase Extraction	Vertical wells are pumped to extract contaminated groundwater, and are under negative pressure to extract volatile contaminants for the water surface, capillary fringe, and the vadose zone soils; extracted groundwater and vapors are treated through chemical, physical, or biological processes.	Effective for VOCs and not ROCs.	Requires high level of effort to implement.	High O&M cost.	**Eliminated –** mostly effective for VOC chemicals not ROCs.
	In-Situ Physical/ Chemical Treatment	Chemical Oxidation	Chemicals such as hydrogen peroxide, potassium permanganate, or Fenton's reagent are injected into the contaminated groundwater to enhance the oxidation state of the aquifer, chemically altering	Effective for chemicals and not ROCs.	Not easily implemented.	High cost	**Eliminated –** not retained; alternative retained in SulTech, 2007

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
			dissolved contaminants to less toxic compounds or precipitants.				
		Chemical Reduction	Chemicals such a zero-valent iron, are injected into the contaminated groundwater to enhance the reduction state of the aquifer, chemically altering dissolved contaminants to less toxic compounds or precipitants.	Not effective for ROCs.	Not easily implemented.	High cost	**Eliminated** – not retained; alternative retained in SulTech, 2007.
		Electrokinetic Separation	Induced electronic current creates an acid front (low pH) at the anode and a base front (high pH) at the cathode; acidic conditions mobilize metal contaminants for transport and collection at the cathode.	Not effective for ROCs.	Not easily implemented.	High cost.	**Eliminated** – not retained; alternative eliminated in SulTech, 2007
		Air Sparging with SVE	Air is injected into the aquifer to mobilize volatile organic chemicals into the unsaturated vadose zone soil; volatile organic chemicals are extracted from the soils with SVE system.	Not effective for ROCs.	Not easily implemented.	High cost.	**Eliminated** – not retained; alternative eliminated in SulTech, 2007.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
		Ozone Sparging with SVE	Ozone is injected into the aquifer to mobilize volatile chemicals into the unsaturated vadose zone soil and create a highly oxygenized environment; mobilized chemicals are extracted from the soils with SVE system.	Not effective for ROCs.	Implementation may conflict with planned reuse	High implementati on and O&M cost, including disposal costs and/or surface treatment	**Eliminated** – not retained; alternative eliminated in SulTech, 2007
		Permeable Reactive Barriers	Passive reactive treatment walls are installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall; these walls allow the water to pass while prohibiting movement of contaminants by employing agents.	Not effective for ROCs	Implementation may conflict with planned reuse	High implementati on and O&M cost	**Eliminated** – not retained; alternative eliminated in SulTech, 2007.
	In-Situ Biological Treatment	Aerobic and Anaerobic Bioremediation	Electron donors, electron acceptors, nutrients, and possibly microorganisms are injected into the contaminated groundwater to create or enhance aqueous biological activity that degrades the contaminants to less toxic or mineralized compounds requires monitoring.	Not effective for ROCs.	Not easily implemented.	High O&M cost.	**Eliminated** – Not effective for ROCs and retained by SulTech, 2007.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
		Phytoremediation	Uses plant uptake to remove, transfer, stabilize, and destroy organic/inorganic chemicals in groundwater; requires monitoring to assess remedial progress.	Not effective for ROCs	May not be implementable with planned reuse	Moderate implementation cost; moderate to low O&M cost	**Eliminated** – not retained; alternative eliminated in SulTech, 2007
Monitoring	Passive	Monitoring	Groundwater is sampled and analyzed for ROCs; results are evaluated and reported to assess if ROCs are in aquifer and migration of the contaminants to potential exposure points.	Effective for all ROCs at low concentrations.	Easily implemented.	Low cost	**Retained** – easily implemented; effective for all ROCs at low concentrations; low cost; slow results
Removal	Pump and Dispose Groundwater contaminants	Pumping	Large volumes of groundwater are pumped from the aquifer to capture the contaminated plume; extracted groundwater is either released to a wastewater disposal facility or is hauled off site for disposal.	Effective for all ROCs; not effective in heterogeneous or tight lithologic conditions; may leave significant concentrations of ROCs behind as the aquifer is dewatered	High level of effort to implement	High implementation and O&M cost; potentially high cost for disposal	**Eliminated** – not retained; alternative eliminated in SulTech, 2007
Containment	Sluury Wall	Low-permeability Wall	Install a low permeability material, such as bentonite, in a trench or through well injections around the perimeter of the COC plume to stops groundwater flow and prevent migration of	Low effectiveness in obtaining a complete seal; may cause hydrogeologic problems such as a groundwater	High level of effort to implement, including permitting; implementation may conflict with	High implementation and O&M cost	**Eliminated** – not retained; alternative eliminated in SulTech, 2007

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
			contaminants; Requires monitoring to assess remedial effectiveness (EPA 1998b)	"mound"; would not lessen the vapor intrusion pathway risk	planned reuse		
STRUCTURES							
No Action	Not Applicable	Not Applicable	No Action	Does not achieve remedial action objectives.	Not acceptable to local government or public.	None	**Retained** – required by NCP.
Surveys	Not Applicable	Manual Screening	Manual screening of structures to identify areas exceeding the cleanup standard from the areas below the cleanup standard. This may be accomplished by scan and static measurements in the field.	Effective at preventing exposure of receptors to contamination; reduces the total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method.	Requires appropriate equipment, instrumentation, and trained personnel.	Moderate cost	**Retained** – for structures that are radiologically-impacted.
Treatment	Removal	Scabbling	Scabbling	Removal of contaminated structural materials with the ROC above RAOs.	Easily implemented.	Moderate cost	**Retained** – removes specific area contamination.
		Demolition	Demolition	Removal of contaminated building materials with the ROC above RAOs.	Easily implemented.	Moderate cost	**Retained** – removes large area contamination.
			Off-site Disposal	Disposal of excavated radioactively contaminated soil and material into a facility licensed to receive low-	Easily implemented.	High cost	**Retained** – effective; quickly implemented; permanent remedy.

TABLE 4-2

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOIL, GROUNDWATER, AND STRUCTURES

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				level radioactive waste.			

Abbreviations and Acronyms::

bgs – below ground surface
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
O&M – operations and maintenance
Q&M – O&M operations and maintenance
RAO – Remedial Action Objective
ROC – radionuclide of concern
ROD – Record of Decision
SVE – volatile organic counpony
VOC – volatile organic compound

TABLE 4-3

GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND STRUCTURES SUMMARY

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
SOIL							
No Action	Not Applicable	Not Applicable	No Action	Does not achieve remedial action objectives.	Not acceptable to local government or public.	None	**Retained** – required by NCP.
Institutional Controls	Institutional Controls	Institutional Controls	Fencing, barriers, and posting signs to restrict land use where there is exposure to potentially contaminated soil. Prohibits activities not specified for the designated land use; prohibits growing produce in native soil. Restricts the use of the parcel to those re-uses that are identified at the time the ROD amendment is signed; includes criteria during and after future development to assure that mitigated exposure conditions are maintained such as covers, barriers, or other engineering controls.	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination.	Requires legal documents and authority to enforce restrictions. Easily implemented.	Low Cost	**Retained** – easily implemented and effective, usually required to restrict activity based on land use.

TABLE 4-3

GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND STRUCTURES SUMMARY

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
Removal	Excavation	Conventional excavation	Excavation of contaminants, soil, and materials with the ROC concentration above RAOs	Effective at removing contamination and preventing long-term exposure to contamination; may expose workers and the environment to contaminants during implementation; uses conventional construction methods; proven technology.	Easily implemented for defined areas of contamination; easily implemented for ROCs; may need to excavate to 10 feet bgs.	Moderate cost (based on previous excavations)	**Retained** – effective for ROCs and quickly implemented; moderate cost.
	Off-site Disposal	Disposal of excavated radioactively contaminated soil and material into a facility licensed to receive low-level radioactive waste.	Transport and dispose of soils at a permitted treatment and disposal facility.	Effective at preventing exposure of receptors to contamination; does not reduce total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method.	Requires appropriate transportation permits and waste characterization. Easily implemented.	High cost	**Retained** – effective; easily and quickly implemented; permanent remedy; high cost.
Containment	Covers	Soil, Asphalt, or Concrete Cover	Placement of a soil, asphalt, or concrete cover over contaminated soil, prevents contact with contamination.	Effective at preventing exposure of receptors to contamination, must be used with land-use controls to maintain protectiveness, susceptible to weathering and cracking.	Paved areas can be easily maintained using conventional methods; soil or asphalt cover could be used in areas currently unpaved. Easily implemented.	Moderate cost	**Retained** – for areas that are paved or require paving to achieve planned land uses; can be used with a soil cover.

TABLE 4-3

GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND STRUCTURES SUMMARY

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
		Manual screening	Manual screening of excavated soil and material to separate the soil and material exceeding the cleanup standard from the soil below the cleanup standard. This may be accomplished by soil sampling and analyses in the field.	Effective at preventing exposure of receptors to contamination; reduces the total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method.	Requires appropriate equipment, instrumentation, and trained personnel.	High cost	**Retained** – for fill areas that need to be excavated.
			STRUCTURES				
No Action	Not Applicable	Not Applicable	No Action	Does not achieve RAOs.	Not acceptable to local government or public	None	**Retained** – required by NCP.
Surveys	Not Applicable	Manual screening	Manual screening of structures to identify areas exceeding the cleanup standard from the areas below the cleanup standard. This may be accomplished by scan and static measurements in the field.	Effective at preventing exposure of receptors to contamination; reduces the total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method.	Requires appropriate equipment, instrumentation, and trained personnel.	Moderate cost	**Retained** – for structures that are radiologically-impacted.
Treatment	Removal	Scabbling	Scabbling	Removal of contaminated structural materials with the ROC above RAOs.	Easily implemented	Moderate cost	**Retained** – removes specific area contamination.
		Demolition	Demolition	Removal of contaminated building materials with the ROC	Easily implemented	Moderate cost	**Retained** – removes large area

TABLE 4-3

GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND STRUCTURES SUMMARY

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				above RAOs.			contamination.
			Off-site Disposal	Disposal of excavated radioactively contaminated soil and material into a facility licensed to receive low-level radioactive waste.	Easily implemented	High cost	**Retained** – effective; quickly implemented; permanent remedy.

Abbreviations and Acronyms:

Bgs – below ground surface
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
RAO – Remedial Action Objective
ROC – radionuclide of concern
VOC – volatile organic compound

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES SUMMARY

Alternatives	Overall Protection	ARAR Compliance	Long-term Effectiveness	Reduction of Toxicity, Mobility, Volume through Treatment	Short-term Effectiveness	Implementability	Cost in Addition to Revised FS for Parcel D	Overall Rank
SOIL ALTERNATIVES								
S-1: No Action	Not protective	Does not meet ARARs	Not Acceptable	Poor	Very Good	Very Good	$0	Not Acceptable
S-2: Institutional controls	Protective	Meets	Good	Poor	Good	Very Good	$0	Good
S-3: Excavation, Disposal, and Institutional controls	Protective	Meets	Good	Poor	Very Good	Very Good	$98,000	Very Good
S-4: Covers and Institutional controls	Protective	Meets	Good	Poor	Good	Very Good	$0	Good
S-5: Excavation, Disposal, Covers, and Institutional controls	Protective	Meets	Very Good	Poor	Very Good	Very Good	$98,000	Very Good
GROUNDWATER ALTERNATIVES								
GW-1: No Action	Not protective	Does not meet ARARs	Not Acceptable	Poor	Good	Excellent	$0	Not Acceptable
GW-2: Long-Term Groundwater Monitoring	Protective	Meets	Good	Poor	Very Good	Very Good	$614,000	Good
GW-3A and GW-3B: VOC Treatment and Short-Term Groundwater Monitoring	Protective	Meets	Very Good	Good	Very Good	Very Good	$180,000	Very Good
GW-4A and GW-4B: VOC and Metal Treatment and Short-Term Monitoring	Protective	Meets	Excellent	Excellent	Very Good	Very Good	$354,000	Excellent

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES SUMMARY

Alternatives	Overall Protection	ARAR Compliance	Long-term Effectiveness	Reduction of Toxicity, Mobility, Volume through Treatment	Short-term Effectiveness	Implementability	Cost in Addition to Revised FS for Parcel D	Overall Rank
IMPACTED STRUCTURES ALTERNATIVES								
R-1: No Action	Not protective	Does not meet ARARs	Poor	Poor	Very Good	Very Good	$0	Not Acceptable
R-2: Survey, Decontamination, Excavation, Disposal, and Release	Protective	Meets	Very Good	Poor	Very Good	Very Good	$29,656,000	Good

Abbreviations and Acronyms:

ARAR – applicable or relevant and appropriate requirement
IC – institutional control
FS – Feasibility Study
VOC – volatile organic compound

FIGURES

Figure ES-1: Ranking of Remedial Alternatives For Soil, Groundwater, and Radiologically-Impacted Sites

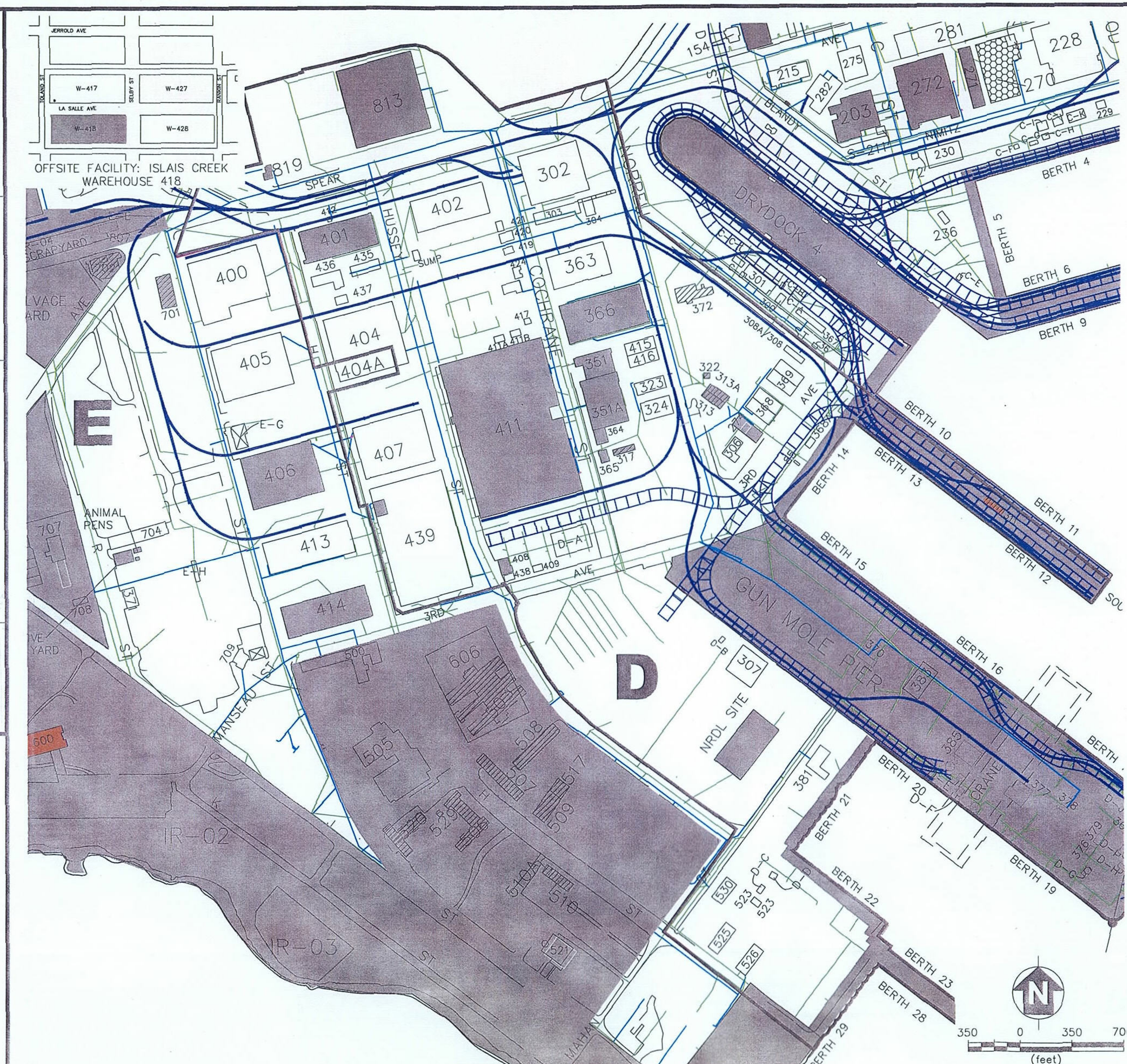
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implement ability	Cost ($ Million)	Overall Rank by Alternative
Soil Alternatives								
Alternative S-1: No Action	Not Protective	Not Applicable	[illegible]	[illegible]	Very Good	[illegible]	0	[illegible]
Alternative S-2: Institutional Controls and Maintained Landscaping	Protective	Meets ARARs	[illegible]	[illegible]	Very Good	Good	0	Good
Alternative S-3: *Excavation, Disposal, Maintained Landscaping, and Institutional Controls*	Protective	Meets ARARs	Good	[illegible]	Very Good	Very Good	0.1[a]	Good
Alternative S-4: Covers and Institutional Controls	Protective	Meets ARARs	Very Good	[illegible]	Very Good	Very Good	0	Good
Alternative S-5: Excavation, Disposal, Covers and Institutional Controls	Protective	Meets ARARs	[illegible]	[illegible]	[illegible]	Very Good	0.1[a]	[illegible]
Groundwater Alternatives								
Alternative GW-1: No Action	Not Protective	Not Applicable	[illegible]	[illegible]	Good	[illegible]	0	[illegible]
Alternative GW-2: Long-Term Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	Good	[illegible]	Very Good	Very Good	0.41[a]	Good
Alternative GW-3A: In Situ Groundwater Treatment with Biological Substrate Injection, Reduced Groundwater Monitoring, and Institutional Controls	Protective	Meets ARARs	Very Good	[illegible]	Very Good	Very Good	0.12[a]	Very Good
Alternative GW-3B: In Situ Treatment with ZVI Injection, Reduced Groundwater Monitoring, and Institutional Controls	Protective	Meets ARARs	Very Good	[illegible]	Very Good	Very Good	0.12[a]	Very Good
Alternative GW-4A: In Situ Groundwater Treatment for VOCs, Reduced Groundwater Monitoring, and Institutional Controls	Protective	Meets ARARs	[illegible]	[illegible]	Very Good	Very Good	0.25[a]	[illegible]
Alternative GW-4B: In Situ Treatment for VOCs and Metals, Reduced Groundwater Monitoring, and Institutional Controls	Protective	Meets ARARs	[illegible]	[illegible]	Very Good	Very Good	0.25[a]	[illegible]
Radiologically-Impacted Sites Alternatives								
Alternative R-1: No Action	Not Protective	Not Applicable	[illegible]	[illegible]	Good	[illegible]	0	[illegible]
Alternative R-2: Survey, Decontamination, Disposal, and Release	Protective	Meets ARARs	Very Good	[illegible]	Very Good	Very Good	29.0[a]	Good

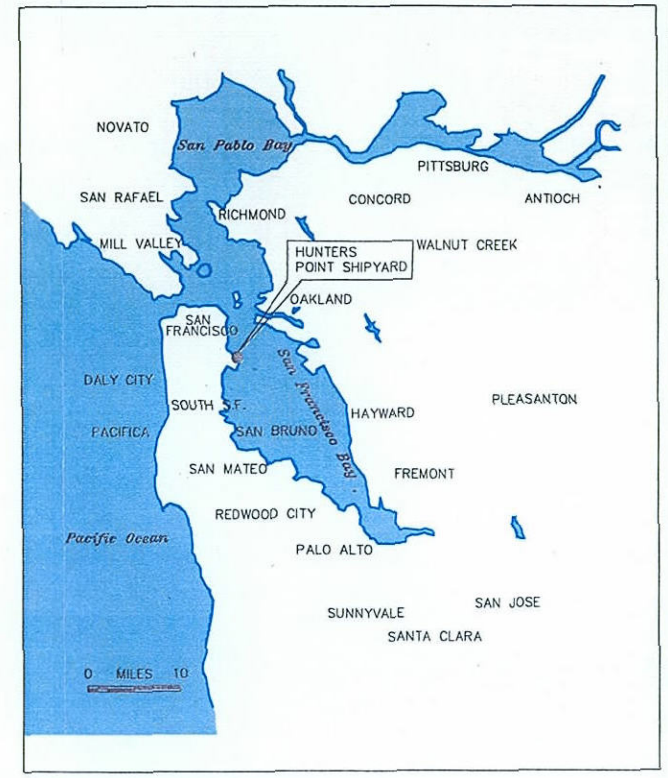
ARAR Applicable or relevant and appropriate requirement
SVE Soil vapor extraction
ZVI Zero-valent iron
a - Additional cost to the Revised FS for Parcel D estimated cost for the alternative

Legend
- Not acceptable
- Poor
- Good
- Very Good
- Excellent

DRAWN BY: AEC | CHECKED BY: | APPROVED BY: RA | DCN: ECSD-2201-0006-0078 | DRAWING NO: BASE-WIDE MAP FIGURE 1-1.DWG

DATE: 04/11/08 | REV: 0 | CTO: 006





LEGEND

- NAVY PROPERTY BOUNDARY (OFFSHORE)
- PARCEL BOUNDARY
- IMPACTED SANITARY SEWER SYSTEM
- IMPACTED STORM DRAIN SYSTEM
- IMPACTED BUILDINGS OR SITES
- DEMOLISHED IMPACTED BUILDINGS/STRUCTURES
- DEMOLISHED BUILDINGS/STRUCTURES
- IMPACTED SITES THAT HAVE OBTAINED REGULATORY RELEASE
- IMPACTED FUDS SITES
- NON-IMPACTED BUILDINGS WITHIN AN IMPACTED SITE, RADIOLOGICAL PRECAUTIONS MAY BE REQUIRED

NOTE

IMPACTED SITES ARE SITES THAT HAVE KNOWN RADIOLOGICAL CONTAMINATION OR WHERE SITE HISTORY INDICATES THAT RADIOLOGICAL CONTAMINATION MAY BE PRESENT.

FOR PLANNING PURPOSES, ALL STORM DRAINS & SANITARY SEWERS SHOULD BE CONSIDERED IMPACTED.

STORM AND SANITARY SEWER LINE LOCATIONS BASED ON DATA FROM HPS CSO (1995) AND THE FINAL HRA (AUG 2004) THAT HAS NOT BEEN FIELD CHECKED.

FIGURE 1-1

BASE-WIDE IMPACTED BUILDINGS, SITES, SANITARY AND STORM DRAIN SEWER SYSTEMS

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CA

TETRA TECH EC, INC.

\\HUNTERSPOINT\PROJECTS\CTO 006\CAD\CTO 006\DWG\BASE WIDE MAP-X\BASE-WIDE MAP FIGURE 1-1.DWG
PLOT/UPDATE: JAN 17 2008 09:56:31

Location Map

TETRA TECH

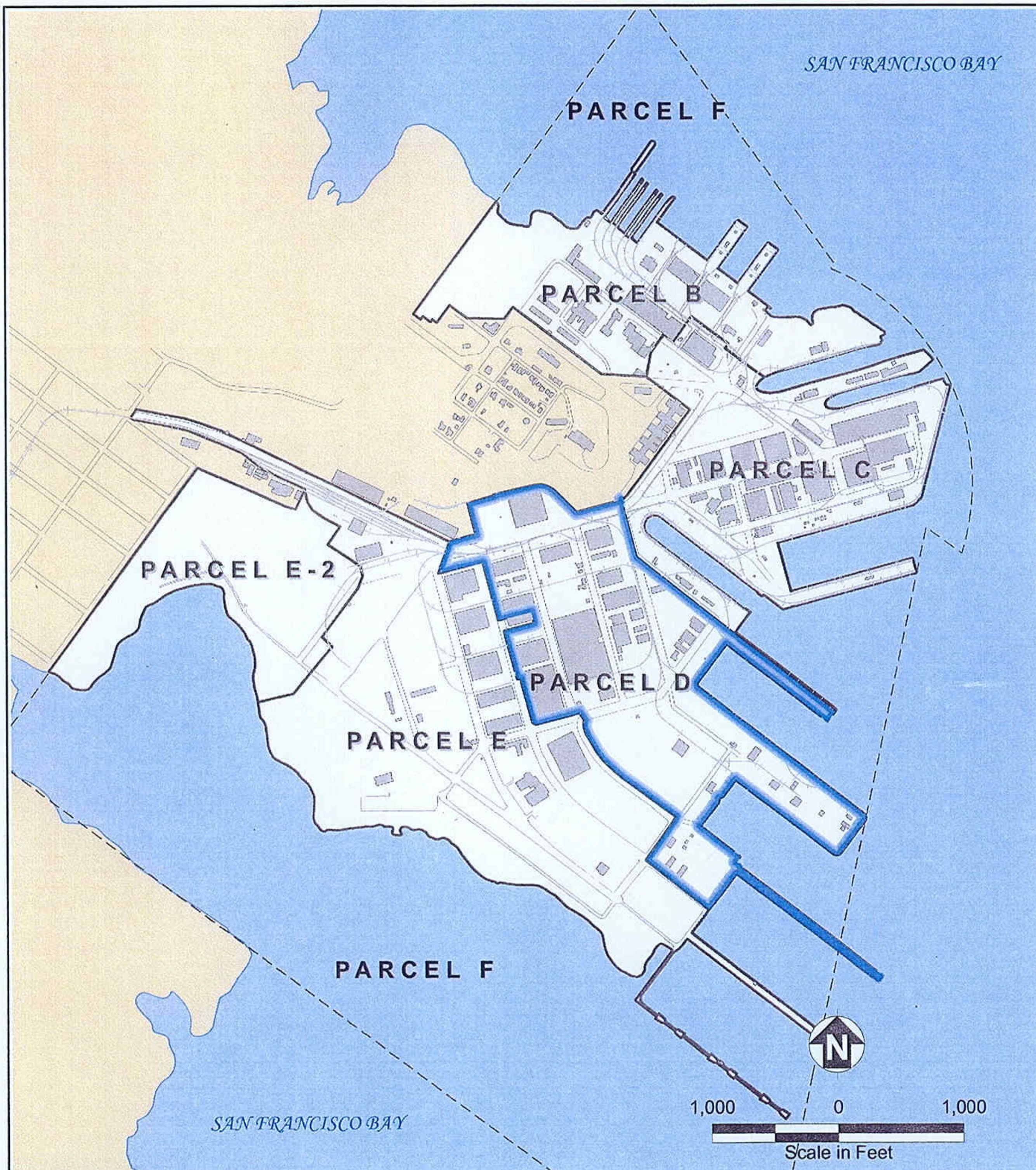
Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-1

HUNTERS POINT LOCATION MAP

Radiological Addendum to the Draft Final Revised Feasibility Study for Parcel D



Location Map

Parcel D Boundary
Other Parcel Boundaries
Parcel F Boundary
Non-Navy Property
Building
Road

TETRA TECH

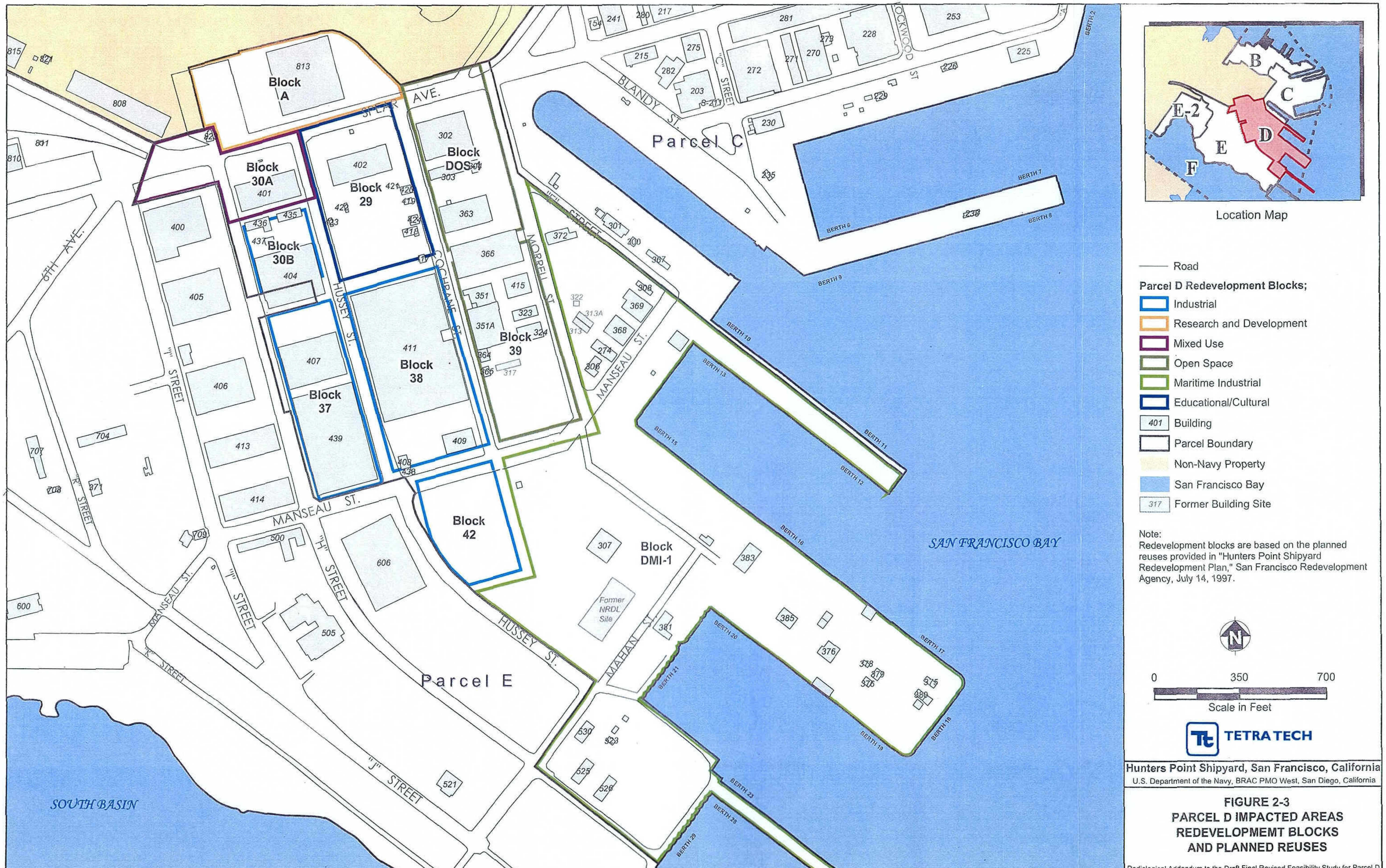
Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-2

FACILITY LOCATION MAP

Radiological Addendum to the Draft Final Revised Feasibility Study for Parcel D

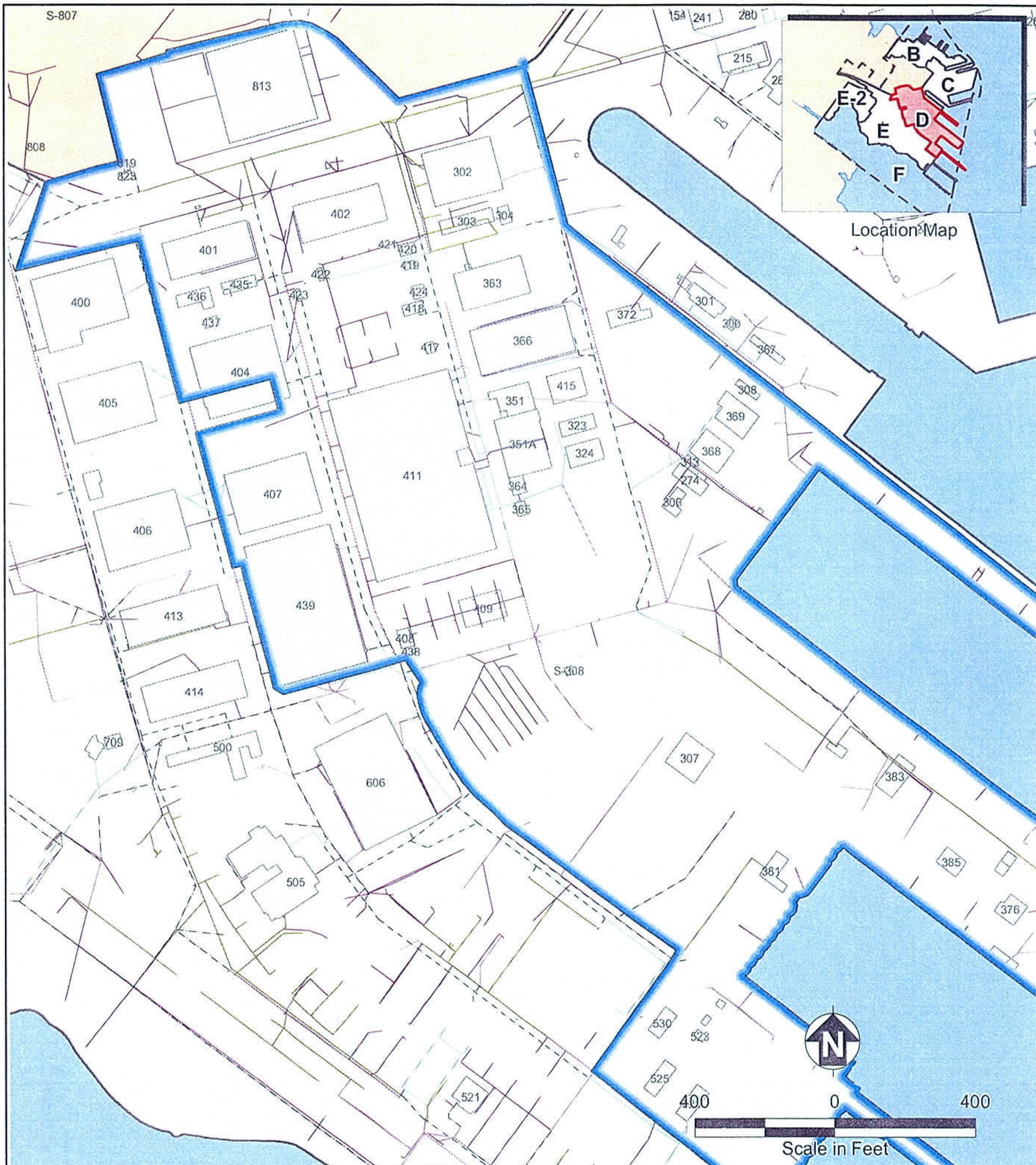


Note:
Redevelopment blocks are based on the planned reuses provided in "Hunters Point Shipyard Redevelopment Plan," San Francisco Redevelopment Agency, July 14, 1997.

TETRA TECH

Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-3
PARCEL D IMPACTED AREAS
REDEVELOPMEMT BLOCKS
AND PLANNED REUSES



Sanitary Sewer Elevation Relative to Groundwater (June 2002)

- Above Groundwater
- Below Groundwater
- Unknown Elevation
- Parcel D Boundary
- Other Parcel Boundaries

Storm Drain Line Relative to Groundwater (June 2002)

- Above Groundwater
- Below Groundwater
- Unknown Elevation
- Building

TETRA TECH

Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-4

STORM DRAIN AND SANITARY SEWER LINE MAP

Radiological Addendum to the Draft Final Revised Feasibility Study for Parcel D

APPENDIX A

RADIOLOGICAL RISK SCREENING ANALYSIS

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N62473-06-D-2201
CTO NO. 0006

APPENDIX A

FINAL

RADIOLOGICAL RISK SCREENING ANALYSIS

April 11, 2008

PARCEL D, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: ECSD-2201-0006-0078

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, CA 92101-8536

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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
cm^2	square centimeter
^{60}Co	cobalt-60
^{137}Cs	cesium-137
DoD	Department of Defense
DON	Department of Navy
DTSC	Department of Toxic Substances Control
dpm	disintegration per minute
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
m^2	square meter
m^3/yr	cubic meters per year
NRC	Nuclear Regulatory Commission
NUREG	US Nuclear Regulatory Commission Regulation
pCi/g	picocurie per gram
^{239}Pu	plutonium-239
^{226}Ra	radium-226
RAGS	Risk Assessment Guidance for Superfund
RESRAD	Residual Radioactivity (Model)
RESRAD-BUILD	Residual Radioactivity-Building (Model)
ROC	radionuclide of concern
SAIC	Science Applications International Corporation
^{90}Sr	strontium-90
^{232}Th	thorium-232

1.0 PURPOSE

The Department of the Navy (DON), U.S. Environmental Protection Agency (EPA), and Department of Toxic Substances Control (DTSC) held a number of focused meetings in 2004 and agreed upon risk assessment methodologies for soil and groundwater that were used for the human-health risk-assessment in the Revised Feasibility Study (FS) for Parcel D (SulTech, 2007). These methodologies were applied to the analyses discussed in this appendix.

This appendix presents the methodology and evaluations used to estimate the dose and risk to future Parcel D residents and construction workers. The objectives of this appendix are to:

- Identify the critical exposure pathways and radiological contaminants that pose primary health concerns.
- Identify the exposure pathways and radiological contaminants that pose little or no threat to human health.
- Estimate the potential dose and risks to human health due to radiological contaminants associated with potential future land-use scenarios.

The remainder of this appendix is organized as follows:

- Section 2.0 presents an overview of the methodology used for the risk analysis.
- Section 3.0 discusses the conceptual site model for Parcel D.
- Section 4.0 identifies the radionuclides of concern (ROC).
- Section 5.0 presents the exposure assessment.
- Section 6.0 presents the uncertainty analysis.
- Section 7.0 presents the references used for this analysis.

Tables, figures, and attachments are presented after Section 7.0.

2.0 RADIOLOGICAL RISK ASSESSMENT METHODOLOGY

The computer codes Residual Radioactivity (Model) (RESRAD) (Department of Defense [DoD], et al., 2000) and Residual Radioactivity-Building (RESRAD-BUILD) (Nuclear Regulatory Commission [NRC], 2000) were used to perform dose and risk modeling of radiologically-impacted sites at Parcel D. RESRAD-BUILD was used to model the impacted buildings (i.e., 274, 351, 351A, 364, 365, 366/351B, 383, 401, 408, and 411. RESRAD was used to model the risk associated with impacted land areas (e.g., former building sites 313, 313A, 317, and 322) and fill areas (e.g., Gun Mole Pier and the Naval Radiological Defense Laboratory Site on Mahan Street). Both RESRAD and RESRAD-BUILD use the isotopes specified as radionuclides of interest and automatically include the long-lived daughter products of these isotopes.

RESRAD and RESRAD-BUILD were used to analyze the exposure scenarios that match planned reuse (San Francisco Redevelopment Agency, 1997). The majority of the input parameters for both RESRAD and RESRAD-BUILD were left as default except where noted. Based upon the results for a critical receptor scenario analysis, all results were run using the bounding resident adult scenario. The following paragraphs apply only to the critical receptor analysis; as noted above, all calculations used for dose and additive risk were run using RESRAD defaults.

The following discussion identifies the best processes to match each of the receptor-specific parameters for FS for Parcel D non-radiological risk and RESRAD analyses. Unfortunately, due to the manner in which indoor and outdoor fractions are used in RESRAD and how they relate to exposure time and frequency as used in the Revised FS for Parcel D, it is impossible to implement all the steps necessary to perform a completely matching calculation.

The difficulty arises from the fact that the RESRAD indoor and outdoor fractions are pervasive across all calculations. Inhalation, soil ingestion, and exposure calculations all use the indoor and outdoor fractions. Inhalation and soil ingestion rates input into RESRAD are total annual rates regardless of location on or off site, whereas rates in the Revised FS for Parcel D correspond to rates only for time spent on site. There are no indications as to what the receptor does off site in the Revised FS for Parcel D. In order to match the total intake quantities (air or soil) either the intake rates or the total on-site fraction must be modified in RESRAD. In order to match the exposure period, the only mechanism available for RESRAD is to adjust the total on-site fraction. Therefore, when matching intake quantities, the preferential method is to modify the intake rates since changes to the on-site fraction would prohibit effective matching of exposure period.

As noted in Section 2.1.5 regarding the inhalation rate, there are cases where the required changes to the intake values would put a parameter outside of RESRAD's accepted range of values for that parameter. In order to estimate the significance of this limitation, scoping calculations were performed using RESRAD default parameters, a worst-case source term with all ROCs in Parcel D present at release limits and the appropriate pathways active. The results of this analysis indicated that at 1,000 years, greater than 95 percent of the dose (with a peak of almost 97 percent at time zero) is due to direct radiation. The second highest contributor ranging from 2.0 to 2.9 percent is from soil ingestion, while inhalation ranges from 1.1 to 1.7 percent of the total dose. Fortunately, the cases where the intake parameters are outside of the RESRAD limits apply only for inhalation rates for the construction and industrial workers. Since the resident adult scenario bounds all exposure scenarios, it was used for combined risk assessments. Thus there are virtually no consequences of having to set the inhalation rate lower than the value needed to give an exact match with the Revised FS for Parcel D in these cases.

Table A.2-1 summarizes changes to RESRAD default parameters necessary to make the receptor scenarios more closely match the Revised FS for Parcel D cases. All other RESRAD parameters were left at default values. The approach taken with comparable Revised FS for Parcel D parameters is described in the following sections of this appendix.

2.1 RESRAD

The RESRAD (NRC, 2000) code is used to estimate the potential risk to an individual from exposure to residual radionuclides in soil or soil-like media. It was used to evaluate the risk associated with impacted soil areas in Parcel D. Site specific results were modeled using default RESRAD parameters for all values except for contaminated area size as noted in Section 5.2.

When looking at various receptor scenarios, the goal of the RESRAD risk modeling approach was to be as consistent as possible with assumptions and inputs used in the Revised FS for Parcel D non-radiological human health risk assessment. To achieve this goal the development of representative parameters for receptor scenarios other than the RESRAD default was required. This was achieved by following the guidance of the EPA Exposure Factors Handbook and the Risk Assessment Guidance for Superfund (RAGS) documents. These guides were also used in development of input parameters for the Revised FS for Parcel D human health risk assessment. Receptor-specific RESRAD values were selected from these documents for recreational, construction, and industrial users in addition to the default resident values. The simplest approach to modeling these scenarios would have been to simply use the values suggested by previous researchers for the various RESRAD receptor types. However, the basis of the receptors defined in the Revised FS for Parcel D are not based upon the same assumptions used in developing the RESRAD receptor types. In order to achieve the best correlation it was necessary to adjust each of the parameters based upon receptor-specific information.

The differences between the parameters for the various receptors essentially are limited to variation among:

- Averaging time for noncarcinogens
- Body weight

- Body surface area
- Exposure duration
- Exposure frequency
- Exposure time
- Inhalation rate
- Soil adherence factor
- Soil ingestion rate

The following section provides an evaluation of the sensitivity of each of these parameters when used in performing calculations with RESRAD that directly parallel the exposure scenarios defined in the Revised FS for Parcel D. This evaluation presents the chemical analysis parameter(s) and indicates the equivalent RESRAD parameter(s). Where possible, like parameters are grouped together.

2.1.1 Averaging Time for Non-Carcinogens and Body Weight

From a chemical analysis standpoint the averaging times are used to distribute the harmful effects of exposure for means of common comparison. EPA guidance assumes that all doses are essentially normalized into an average daily dose. By use of an averaging time, a long-term low dose is just as unfavorable as a short-term high dose. Body weight is a necessary component in order to obtain doses in terms of milligrams per kilogram of body weight per day.

When performing radiological calculations, however, neither one of these factors is included in risk determination. This guidance is given explicitly in Chapter 10 of the RAGS document. The rationale is that the determination of dose conversion factors for radionuclide exposure is performed in a different manner than slope factors for chemical exposure. In essence the body weight and averaging time factors are already included or unnecessary because of the manner in which the dose conversion factor calculations are performed. Therefore, consistency between the averaging time and receptor body weight parameters in the Revised FS for Parcel D and RESRAD is not necessary.

2.1.2 Body Surface Area and Soil Adherence Factor

The body surface area parameter is used in chemical analysis for the dermal contact pathway. Since radiological analysis does not have a direct contact pathway, there is no corresponding body surface area parameter. Any exposure resulting from direct contact with radiologically contaminated material would be accounted for in the external radiation pathway.

2.1.3 Exposure Frequency and Exposure Time

The exposure frequency and time are used in Revised FS for Parcel D analysis to define the exposure for the various receptors. The exposure time gives the number of hours per day that a receptor is on site and exposed to harmful substances. Exposure frequency specifies the number of days per year that a receptor is at the site. The product of the exposure time and exposure frequency yields the total number of hours spent on site in a year. For purposes of this discussion, this product shall be referred to as the exposure period.

There are no directly correlated exposure frequency or time parameters in RESRAD. Rather than using these factors explicitly, RESRAD uses parameters for indoor fraction and outdoor fraction. The former accounts for time spent inside a building at the site while the latter accounts for time on site but outside. When added together these two values give the total on-site fraction. The primary difference between time indoors and time outdoors from a calculational standpoint is that indoor time accounts for additional shielding from direct radiation offered by the building's materials. In order to be conservative, however, the total on-site fraction is allocated to the outdoor time fraction since the resulting doses are higher, resulting in a high risk number.

The indoor and outdoor fractions are unitless parameters and thus can be applied across any given time period. Using the RESRAD default indoor and outdoor fractions of 0.5 and 0.25, respectively, a default RESRAD receptor spends 18 hours per day on site. RESRAD uses a 365-day-year and there is no means of adjusting the number of days per year. Therefore, the default receptor spends a total time of 6,570 hours on site a year.

In order to match the exposure frequency in the Revised FS for Parcel D, the total on-site fraction is adjusted such that the exposure period (total number of hours of exposure per year) is consistent with the parameters from the Revised FS for Parcel D. The technique of matching total annual hours on site is consistent with suggestions given in the RESRAD manual for modeling receptors with exposure scenarios different from the default receptor.

2.1.4 Exposure Duration

The exposure duration indicates how many total years the receptor will spend on site. By default RESRAD uses a value of 30 years for exposure duration. This parameter is directly modifiable by the user. The Parcel D Revised FS uses values of 1, 6, 24, and 25 years based upon receptor type and age.

2.1.5 Inhalation Rate

The Revised FS for Parcel D analysis uses inhalation rates based upon the receptor scenario and age. Inhalation rates in the Revised FS for Parcel D are given in terms of cubic meters per hour. RESRAD has a user-defined inhalation rate that by default is 8,400 cubic meters per year (m^3/yr). RESRAD contains specialized templates for recreational and industrial workers with inhalation rates of 14,000 m^3/yr and 11,400 m^3/yr, respectively. If the Revised FS for Parcel D inhalation rates are converted to the same units used in RESRAD, rates of 3,679 m^3/yr, 7,270 m^3/yr, and 21,900 m^3/yr are obtained.

At first it would appear that simply using the converted Revised FS for Parcel D rates in RESRAD analyses would yield the desired results. Unfortunately, RESRAD has a maximum annual inhalation rate of 20,000 m^3/yr. This limitation prevented direct matching of the 21,900 m^3/yr rate used in certain Revised FS for Parcel D cases. The actual modeled values for the various receptors analyzed are presented in Table A.2-1. Since the inhalation pathway is not a critical pathway for risk, the difference in the annual breathing rate does not yield a significant difference in the estimated risk (as indicated by the fraction of total risk in Table A.5-5).

2.1.6 Soil Ingestion Rate

Soil ingestion rates in the Revised FS for Parcel D are given in terms of milligrams of soil per day. RESRAD uses soil ingestion rates in terms of grams of soil per year with a default value of 36.5 grams per year. Similarly to the inhalation rate, the best match is to ensure that the annual soil intake volume is equal for both the Revised FS for Parcel D and RESRAD cases when exposure time and frequency are factored in.

2.2 RESRAD-BUILD

RESRAD-BUILD (NRC, 2000) is a modeling code used to estimate the potential radiological risk to an individual who works or lives in a building with residual radioactive material. It was used to evaluate the risk associated with occupying Parcel D-impacted buildings. The focus of this modeling was to estimate the increased cancer risk associated with any residual radioactive material left in the buildings after the buildings have been surveyed and released. Residual radioactive material is defined as any radioactive material below the residual cleanup goals. RESRAD-BUILD is similar to RESRAD in that the user can construct the exposure scenario by adjusting the input parameters. Typical building exposure scenarios include long-term occupancy (residential and industrial) and short-term occupancy (recreational and construction). The estimated dose can be the total (individual) dose to a single receptor spending time at various locations or the total (collective) dose to a workforce decontaminating the building. For purposes of these analyses, RESRAD-BUILD was run in individual dose mode.

RESRAD-BUILD has several input parameters that are grouped into the categories of building, source, and receptor. Using RESRAD-BUILD, buildings can be modeled as one-, two- or three-room structures. For simplicity of modeling, all buildings were modeled as a single-room structure with a default interior height of 2.5 meters. A room area of 100 square meters (m^2) was selected to be representative of a typical survey unit size. The source for each building was modeled as an area source that covered the complete floor area of the building, based on the assumption that the residual radioactive material would be uniformly distributed over the floor surface. The source activity was from the ROCs at the remediation goals. Receptor inputs were taken as the default values and the receptor was located in the middle of the building. All other building parameters used the default input value.

3.0 CONCEPTUAL SITE MODEL

This section presents the conceptual site model for Parcel D radiological risk analysis. The site model provides a summary of the sources of the radionuclide contaminants on site and presents the affected environmental media. Additionally, the potential receptors and pathways through which receptors may receive radiological dose are noted. The conceptual site model for Parcel D is presented in Figure A.3-1, which indicates which computer code was used to model the risk to the indicated receptor by the indicated pathway. Radiological pathways that are not active for this analysis are excluded from the site model.

3.1 SOURCES OF SITE CONTAMINANTS

Details on the historical activities at Parcel D contributing to the existing radiological contamination are presented in Section 2.1.2 of the Radiological Addendum to the Revised FS for Parcel D.

3.2 AFFECTED ENVIRONMENTAL MEDIA

Previous Parcel D activities have introduced radioactive contaminants to land areas and buildings. Contaminated media in the form of discrete radioactive sources as well as distributed contamination from leaks or spills of radioactive material are potentially present at impacted areas of Parcel D. Contamination of building surfaces and existing concrete and asphalt resulting from leaks, spills, and process wastes is also potentially present.

3.3 POTENTIALLY EXPOSED RECEPTORS

The 1997 redevelopment plan identifies planned reuses for the entire Parcel D area. Table A.3-1 shows the impacted areas of Parcel D, the planned reuse, and associated exposure scenario.

The exposure scenario establishes the receptor parameters to be modeled. The potential receptors considered for evaluation were selected to be consistent with the human health risk assessment provided in the Revised FS for Parcel D and are as follows:

- Resident (adult and child)
- Industrial worker (adult)
- Recreational user (adult and child)
- Construction worker (adult)

Although the impacted land areas in Parcel D only fall into the residential and recreational exposure scenarios, all four receptor categories listed above were modeled. These additional evaluations provide information on potential risks for all potential reuses in the event that the redevelopment plan is revised.

3.4 EXPOSURE PATHWAYS

As discussed in the human health risk assessment in the Revised FS for Parcel D, a complete exposure pathway consists of four elements, as follows:

- A source and mechanism of chemical release
- A retention or transport medium (or media in cases involving transfer of chemicals)
- A point of potential human contact with the contaminated medium (referred to as the exposure point)
- An exposure route (such as ingestion) at the contact point

If any of these elements is missing (except in a case where the source itself is the point of exposure), then the exposure pathway is considered incomplete. For example, if receptor contact with the source or transport medium does not occur, then the exposure pathway is incomplete and is not quantitatively evaluated for risk. Similarly, if human contact with an exposure medium is not possible, the exposure pathway is considered incomplete and is not evaluated.

For the potentially contaminated building surfaces the exposure pathways are external radiation from contaminated surfaces and inhalation of re-suspended contaminated dust.

The exposure pathways for the impacted soils at Parcel D present a more complicated analysis. The complete pathways, based on the four criteria listed above, are external radiation, soil ingestion, and inhalation.

3.4.1 External Radiation Pathway

The external radiation pathway is identified as potentially complete for all receptors. Exposure to external radiation is the result of radiation emanating from radionuclides present in the soil or other contaminated media.

3.4.2 Soil Ingestion Pathway

The soil ingestion pathway is identified as potentially complete for all receptors. This pathway corresponds to direct ingestion of soil.

3.4.3 Inhalation Pathway

The inhalation pathway is identified as potentially complete for all receptors. This pathway corresponds to inhalation of radiologically contaminated dust and soil particles.

3.4.4 Drinking Water Ingestion Pathway

The drinking water ingestion pathway is not identified as a complete pathway for all receptors. Evaluations of the A-aquifer and the B-aquifer suggest that these aquifers should not be considered a potential source of drinking water. However, the exposure pathway associated with residential use of groundwater in the B-aquifer was included in the Revised FS for Parcel D because of agreements with the Base Closure Team on the human health risk assessment methodology and are included with RESRAD modeling performed for Parcel D for consistency.

3.4.5 Plant Ingestion

The planned land use restrictions for Parcel D would preclude a future site user from growing produce therefore this pathway is deemed incomplete for purposes of this analysis.

3.4.6 Meat Ingestion

The planned land use restrictions for Parcel D would preclude a future site user from raising livestock for consumption therefore this pathway is deemed incomplete for purposes of this analysis.

3.4.7 Milk Ingestion

The planned land use restrictions for Parcel D would preclude a future site user from keeping milk producing animals on the site therefore this pathway is deemed incomplete for purposes of this analysis.

3.4.8 Aquatic Foods

There are no potential sources (i.e. lakes, ponds, streams) of aquatic foods currently in the Parcel D area. Furthermore, should any man-made aquatic bodies be created as part of the redevelopment efforts, the planned land use restrictions for Parcel D would preclude a future site user from obtaining aquatic foods from these areas. This pathway has thus been deemed incomplete for purposes of this analysis.

3.4.9 Radon

Based on guidance presented in the white paper Using RESRAD in a CERCLA Radiological Assessment (SAIC 2002), the radon pathway was not included. The white paper indicates that current radon limits and guidelines are not risk based and analyzing radon using RESRAD results in a high degree of uncertainty. This pathway was deemed not suitable for inclusion with this analysis.

4.0 RADIONUCLIDES OF CONCERN

The radionuclides identified in Table A.4-1 (cesium-137 [^{137}Cs], cobalt-60 [^{60}Co], plutonium-239 [^{239}Pu], radium-226 [^{226}Ra], strontium-90 [^{90}Sr], thorium-232 [^{232}Th], hydrogen-3 [^{3}H] and uranium-235 [^{235}U]) are the constituents of potential concern (or radionuclides of concern) and are called the ROCs at Parcel D. Typically there is no background radioactivity associated with building materials, with the exception of building material made from earthen media (e.g., tiles, concrete, stone, etc.). To simplify the RESRAD-BUILD evaluations being performed, it is assumed that the impacted buildings in Parcel D do not have materials of construction with naturally occurring elevated levels of radioactivity. For simplifications in RESRAD it is assumed that all soil ROCs are present at each site being modeled. While this may add extra ROCs to certain areas, it ensures that the results presented in this analysis conservatively bound the anticipated scenarios.

5.0 EXPOSURE ASSESSMENT

The Revised FS for Parcel D provides both total and incremental risk associated with chemical constituents. To combine the chemical risk and radiological risk, the same approach used in the Revised FS for Parcel D to calculate chemical risk must be taken, namely, calculating total risk from ROCs inclusive of background and calculating incremental risk from the ROCs present at levels that do not include background. Of the ROCs for Parcel D, only ^{226}Ra is naturally occurring. ^{137}Cs and ^{90}Sr may be present in trace quantities because of fallout resulting from nuclear weapons testing. For the purposes of the radiological modeling, the background concentration for the ROCs other than ^{226}Ra are assumed to be essentially zero (i.e., zero picocuries per gram [pCi/g]). The ^{226}Ra background concentration is assumed to be the measured background level of 0.5 pCi/g.

To estimate the total risk from radiologically-impacted buildings, the background concentration of the ROCs is assumed to be zero (i.e., zero disintegration per minute [dpm]/100 square centimeters [cm^2]). This is a reasonable assumption since none of the ROCs are found in building materials except for ^{226}Ra, which can be found in building material made of earthen materials (i.e., cement, ceramic tiles). However, as a conservative modeling measure, the background concentration of ^{226}Ra in building materials is also assumed to be zero.

The risks associated with impacted sites at Parcel D are presented in this section. Summary dose and risk reports for RESRAD and RESRAD-BUILD calculations are provided on CD as Attachment 1 to this appendix.

5.1 RESRAD-BUILD

To estimate the total risk from impacted buildings the background concentration of the ROCs is assumed to be zero (e.g., zero dpm/100 cm^2). This is a reasonable assumption since none of the ROCs are found in building materials expect for ^{226}Ra, which can be found in building material made of earthen materials (i.e., cement, ceramic tiles) resulting in a negligible risk associated with radioactive constituents in building materials. Therefore the total dose and risk is equivalent to the incremental dose and risk. To estimate the incremental dose and risk from impacted buildings the ROCs are assumed to be at the remediation goals listed in Table A.4-1. Cases were run to estimate the dose and risk. For buildings with the same ROCs, a single case was run and the results applied to all like buildings. Multiple runs were not necessary to identify the critical exposure scenario (i.e., the scenario that presents the greatest risk). The reason for this is that occupancy time is the primary driver for the calculated risk: as occupancy time increases, so does the associated risk. Therefore, the resident scenario is the critical scenario providing the greatest risk estimate. The RESRAD-Build results are presented in Table A.5-1.

The combined total and incremental risk (e.g., both chemical and radiological) was derived by reviewing the Revised FS for Parcel D and locating grid points in close proximity to the impacted building. The risk for the impacted buildings estimated from RESRAD-BUILD and the Revised FS for Parcel D are presented in Table A.5-2.

5.2 RESRAD

The computer code used to model the chemical risk has a different set of user input parameters than RESRAD. Section 2.1 and its subsections above give some indication of the differences. The differences cause considerable difficulty in doing a direct matching calculation. Due to the inherent differences between the input parameters used for the Parcel D chemical risk assessment and the RESRAD input parameters, the default RESRAD parameters were used when estimating risk associated with residual radioactivity at Parcel D radiologically-impacted land areas. The only exception was the size for the area of contamination. For land areas smaller than 1,000 m^2 the actual size of the land area was used.

A land area of 1,000 m^2 was used instead of the default land area of 10,000 m^2 to accurately reflect the maximum size of a survey unit. Revising the default land area was done to be consistent with planned area of survey units for outside areas of 1,000 m^2. Using the smaller area will reduce the total risk for the modeled area.

To estimate the total risk from radiologically-impacted soil sites the background concentrations of the ROCs other than ^{226}Ra were assumed to be essentially zero (e.g., zero pCi/g). The ^{226}Ra background concentration is assumed to be the measured background level of 0.5 pCi/g. The ROCs are assumed to be present at equivalent fractions of the respective remediation goals listed in Table A.4-1 such that the sum of the fractions does not exceed one (i.e., unity rule). Table A.5-3 presents the total dose and risk from impacted soil sites estimated using RESRAD.

To estimate the incremental risk from impacted soil sites, the ROCs are assumed to be present at equivalent fractions of the respective remediation goals listed in Table A.4-1 such that the sum of the fractions does not exceed one (i.e., unity rule). The incremental dose and risk for the impacted soil sites estimated from RESRAD are presented in Table A.5-3.

The combined total and incremental risk (e.g., both chemical and radiological) was derived by reviewing the Revised FS for Parcel D and locating grid points in close proximity to the impacted soil sites. Chemical and radiological risks were added to yield combined risk. The risk for the impacted sites estimated from RESRAD and the Revised FS for Parcel D are presented in Table A.5-4.

In addition to site specific dose and risk assessment, several supporting studies were performed as part of this analysis. The supporting studies included a critical exposure scenario evaluation, critical pathway evaluation, cover depth study, and a contamination area study. The results of these studies are documented in the following subsections.

5.2.1 Critical Exposure Scenario Evaluation

An evaluation was performed to identify the critical exposure scenario based on the exposure scenarios identified in Section 3.3 (resident, industrial worker, recreational user, and construction worker). A secondary study was performed on the receptor scenario results to evaluate what percentage each ROC contributed to the total risk. A baseline case was run using the RESRAD parameters as listed in Table A.2-1 was run for each exposure scenario. All other parameters were set at the default RESRAD parameters and the ROCs at the values listed in Table A.4-1.

The modeling results indicated that the resident exposure scenario is the critical exposure scenario. The results are provided in Table A.5-5.

The modeling results indicated that ^{232}Th had the greatest contribution to the total risk of all the radionuclides evaluated at about 62 percent of total risk, and the next highest contributor was ^{226}Ra at approximately 37 percent. ^{226}Ra and ^{232}Th combined contributed approximately 99 percent of the total risk. These results are shown in Table A.5-6.

5.2.2 Critical Pathway Evaluation and Contamination Area Study

An evaluation was performed to identify the critical exposure pathway based on the pathways identified in Section 3.4 (external radiation, soil ingestion, inhalation, and drinking water). A baseline case using default RESRAD parameters and the ROCs at the values listed in Table A.4-1 was modeled to determine the risk contribution for each pathway. Additional cases were modeled using the Revised FS for Parcel D exposure areas for residential and nonresidential exposures (e.g., 232 m^2 and 2,032 m^2).

The modeling results indicated that the drinking water pathway did not contribute to the risk at the maximum risk value (exposure period equal to year zero). The drinking water pathway does become more important as increased time goes on and reaches a total percent contribution of about 25 percent at the 1,000-year exposure period. However, the external radiation pathway still dominates total risk contribution at around 75 percent of the total risk at 1,000 years. The critical pathway evaluation results are provided in Table A.5-7.

5.2.3 Cover Depth

Since the external radiation pathway is the critical pathway, an analysis of the cover depth was performed. The cover depth is the thickness of non-impacted material (e.g., soil, asphalt) that is placed over the impacted soil area. The RESRAD default cover depth is zero, meaning that the receptor is directly exposed to the impacted soil. As the cover depth increases the resulting risk to the receptor is reduced. For the purpose of this analysis the cover depth was modeled at thicknesses of zero inches, 4 inches, 12 inches, and 24 inches. Additionally, the RESRAD default cover erosion rate was set to zero (e.g., cover depth maintained) to account for the institutional controls proposed in the Revised FS for Parcel D.

The modeling results are presented in Table A.5-8 and show that at cover depths of 1 foot or greater, the only pathway that contributes to the total risk is the external radiation pathway. At a 2-foot cover depth, the risk is reduced to the 10^{-7} level.

6.0 UNCERTAINTY ANALYSIS

Any comprehensive risk analysis must also consider the effects of uncertainty on input parameters. This analysis is no different; however, rather than perform explicit uncertainty analyses, which would have required countless additional RESRAD runs, an approach was taken that minimized the need for additional modeling computations. U.S. Nuclear Regulatory Commission Regulation NUREG-6697 (NRC, 2000) was used as the basis for the uncertainty analysis.

One of the primary purposes of NUREG-6697 was to study the effect of various parameter distributions on the final results of RESRAD analyses. As part of the NUREG study, multiple RESRAD runs were conducted for selected isotopes while varying a single parameter.

The majority of the RESRAD analysis relied on default parameters for the model. Since the RESRAD default parameters are developed to be representative of a wide range of scenarios there is considerable conservatism built into them. For those parameters which were changed from default values, the main purpose of the analysis contained in Appendix A was to provide risk values which could be added to those in the chemical FS analysis to obtain total risk. In some cases this added even more conservatism, such as by using high outdoor fractions, leading to higher direct exposure rates due to less shielding from structure walls. These changes were for a specific reason and the chemical and radiological risks are to be added. Actual field data will be used when calculating final dose and risk estimates.

The excluded pathways were selected primarily due to planned land use restrictions to be enforced after Parcel D has been turned over for redevelopment. It is assumed that adequate enforcement of the land use restrictions will be provided to eliminate the need to evaluate any potential use contrary to the restrictions (i.e. user activities resulting in what should be an inactive pathway becoming active).

In the case of the radon pathway, guidance presented in a White Paper titled *Using RESRAD in a CERCLA Radiological Risk Assessment* released by the Buffalo District Office of the U.S. Army Corp of Engineers in October 2002 indicates the radon model in RESRAD has a high degree of uncertainty. Furthermore it notes that existing radon limits and guidelines are based on concentration and <u>not</u> risk. As such the radon pathway is typically excluded from dose calculations and subsequent risk. Typically direct measurements are recommended as a better alternative to modeling.

Since the isotopes included in the NUREG-6697 study cover the majority of the ROCs at Hunters Point Shipyard, it was determined that the conclusions of the NUREG-6697 study could be used as the basis for the uncertainty analysis for the modeling done as part of the Revised FS for Parcel D Addendum. The uncertainty considerations for each ROC are discussed separately below.

Strontium-90

The most critical parameter affecting dose and subsequent risk from ^{90}Sr used in these analyses is the contaminated zone thickness. No other parameters used in this analysis had the potential to have any substantial impact on the results. As previously mentioned, the contaminated zone was dependent on the particular scenario being modeled. In all cases, however, the thickness was selected to be very conservative, and it is fully expected that the results presented in this analysis bound the actual case. It is therefore concluded that the conservatism built into this analysis eliminates the need to run additional uncertainty cases for ^{90}Sr.

Cesium-137

Dose and subsequent risk due to ^{137}Cs is primarily due to the external radiation pathway. The density and thickness of the cover material are the key parameters used in the RESRAD analysis that affect the risk associated with ^{137}Cs. Changes to the external gamma shielding factor also can affect the results to a lesser extent.

The RESRAD default cover material density was used for all analyses performed. The default was designed to be representative of the body of soil types. In some cases, an asphalt cover was modeled with the same default soil density. In reality, asphalt would have a greater density than the default soil value. The specific density is dependent upon the asphalt-laying process. By underestimating the density of asphalt, a certain measure of conservatism has been built into the results presented in this document. It is therefore reasonable to assume that any uncertainty associated with the cover material density is minimal and a full uncertainty analysis for a range of cover material densities is not necessary.

The selected cover thicknesses were selected based upon information in the Parcel D Revised FS (SulTech, 2007) and are consistent with average modern practices for site preparation. No additional runs are required to evaluate the uncertainty with this parameter.

The external gamma-shielding factor is a measure of how much shielding is offered by the building structures for a site receptor. This analysis used the RESRAD default value; however, since all receptor time was assumed inside the value selected for the gamma-shielding factor has no bearing on the final results. No explicit uncertainty analysis was performed for this parameter.

Radium-226

^{226}Ra is another nuclide with the majority of dose (for this analysis) resulting from the external radiation pathway. ^{226}Ra has a relatively long half-life of 1,600 years. Due to its longevity, the most important parameters affecting dose from ^{226}Ra in order from highest to lowest are thickness and density of the contaminated zone.

As noted for ^{90}Sr, the contaminated zone thickness has conservatism built in and thus does not require further uncertainty analysis. The density of the contaminated zone was modeled as the RESRAD default. All RESRAD default values are selected to provide conservative but reasonable estimates to a wider range of analyses. There is no added benefit to conducting more detailed uncertainty calculations for the ^{226}Ra dose based risk with varying contaminated zone densities.

Plutonium-239

^{239}Pu with a 24,000-year half-life has the contaminated zone thickness as the most influential parameter for ^{239}Pu dose in these analyses. The variability in results due to changes in this parameter is far greater than any other parameters. Since the previous discussions have established that the contaminated zone thickness has substantial conservatism included in it, there is no need to perform additional uncertainty calculations.

Thorium-232

Although ^{232}Th was not directly studied by NUREG/CR-6697, ^{230}Th was included in the study. For purposes of this analysis it is assumed that ^{230}Th and ^{232}Th would behave similarly. ^{232}Th has an extremely long half-life on the order of 14 billion years. Its primary contribution to dose is through the external pathway although the groundwater pathway becomes increasingly more important at longer times. It is unknown if the groundwater pathway surpasses direct exposure at some point since this analysis was only modeled out to 1,000 years. Thickness of the contaminated zone is the most sensitive parameter for thorium. As noted above, conservatism has been used in selecting the contaminated zone thickness; thus no additional uncertainty studies were necessary for ^{232}Th. Furthermore, the fact that the groundwater on Parcel D is not considered a viable source of drinking water further limits the impacts of uncertainty in the ^{232}Th concentration.

7.0 REFERENCES

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TABLES

TABLE A.2-1

MODIFIED RESRAD INPUT PARAMETERS FOR CRITICAL EXPOSURE SCENARIO EVALUATION

	RESRAD	Resident		Recreational		Industrial	Construction
	Default	**Adult**	**Child**	**Adult**	**Child**	**Worker**	**Worker**
Exposure duration (yr)	30	24	6	24	6	25	1
Exposure frequency (day/yr)	IF:0.5	IF:0	IF:0	IF:0	IF:0	IF:0	IF:0
Exposure time (hr/day)	OF:0.25	OF:0.959	OF:0.959	OF:0.0713	OF:0.0713	OF:0.2283	OF:0.2283
Inhalation rate (m^3/yr)	8400	7270	3679	7276	3682	20000	20000
Soil ingestion rate (g/yr)	36.5	36.5	73.0	5.85	11.7	18.25	120.5

Abbreviations and Acronyms:

day/yr – days per year
g/yr – grams per year
hr/day – hours per day
IF – Indoor fraction
m^3/yr – cubic meters per year
OF – outdoor fraction
yr – year

TABLE A.3-1

SITES AND SELECTED PARAMETERS FOR PARCEL D REVISED FS RADIOLOGICAL ANALYSIS

Site or Area	Planned Reuse[a]	Exposure Scenario	Cover Details
313 Site	Maritime-Industrial	Industrial	Asphalt, 4 inches
313A Site	Maritime-Industrial	Industrial	Asphalt, 4 inches
317 Site	Open Space	Recreational	Soil, 24 inches
322 Site	Open Space	Recreational	Soil, 24 inches
364 Site	Open Space	Recreational	Soil, 24 inches
365 Site	Open Space	Recreational	Soil, 24 inches
383 Site	Maritime-Industrial	Industrial	Asphalt, 4 inches
408 Site	Industrial	Industrial	Asphalt, 4 inches
Gun Mole Pier	Maritime-Industrial	Industrial	Asphalt, 4 inches
Naval Radiological Defense Laboratory Site on Mahan Street	Maritime-Industrial	Industrial	Asphalt, 4 inches
Sanitary Sewers / Storm Drains	Industrial, Maritime-Industrial, Mixed Use, and Research and Development	Residential	Varies

Notes:

[a] Planned reuse from San Francisco Redevelopment Agency (1997).

Abbreviations and Acronyms:

FS – Feasibility Study

TABLE A.4-1

REMEDIATION GOALS

Radionuclide	Surfaces (dpm/100 cm^2)		Soil[c] (pCi/g)	
	Equipment, Waste[a]	Structures[b]	Outdoor Worker[d]	Residential[d]
cesium-137	5,000	5,000	0.113	0.113
cobalt-60	5,000	5,000	0.0602	0.0361
plutonium-239	100	24.7	14.0	2.59
radium-226	100	100	1.0[e]	1.0[e]
strontium-90	1,000	1,000	10.8	0.331
thorium-232	1,000	36.5	2.7	1.69
hydrogen-3	5,000	5,000	4.23	2.28
uranium-235	5,000	488	0.398	0.195

Notes:

[a] These limits are based on AEC *Regulatory Guide 1.86* (1974). Limits for removable surface activity are 20 percent of these values.

[b] These limits are based on 25 mrem/y, using Decontamination and Decommissioning Version 2 or *Regulatory Guide 1.86*, whichever is lower.

[c] EPA PRGs for two future-use scenarios.

[d] The on-site and off-site laboratory will ensure that the MDA meets the listed release criteria by increasing sample size or counting time as necessary. The MDA is defined as the lowest net response level, in counts, that can be seen with a fixed level of certainty, customarily 95 percent. The MDA is calculated per sample by considering background counts, amount of sample used, and counting time.

[e] Limit is 1 pCi/g above background; not to exceed 2 pCi/g total, per agreement with EPA.

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm^2 – square centimeter
dpm – disintegration per minute
EPA – U.S. Environmental Protection Agency
MDA – minimum detectable activity
mrem/y – millirem per year
pCi/g – picocurie per gram
PRG – Preliminary Remediation Goal

TABLE A.5-1

RESRAD-BUILD RESULTS[a]

Parcel D Impacted Sites	Radiological Risk[b]	Dose[c]
274	3.46×10^{-6}	3.57
351	4.17×10^{-6}	28.5
351A	4.73×10^{-6}	32.9
366/351B	3.46×10^{-6}	3.57
401	1.34×10^{-6}	0.644
411	9.26×10^{-6}	11.0
813	2.77×10^{-7}	0.69
819	3.18×10^{-6}	2.89

Notes:

[a] Total risk and dose is equivalent to incremental risk and dose
[b] Total excess lifetime carcinogen risk
[c] millirem per year

TABLE A.5-2

COMBINED RISK FOR RADIOLOGICALLY-IMPACTED BUILDINGS

Combined Total Risk			
Parcel D Impacted Sites	**Radiological Risk[a]**	**Chemical Risk[b]**	**Combined Risk**
274	3.46×10^{-6}	2.00×10^{-5}	2.35×10^{-5}
351	4.17×10^{-6}	1.00×10^{-5}	1.42×10^{-5}
351A	4.73×10^{-6}	3.00×10^{-6}	7.73×10^{-6}
366/351B	3.46×10^{-6}	1.00×10^{-5}	1.35×10^{-5}
401	1.34×10^{-6}	8.00×10^{-6}	9.34×10^{-6}
411	9.26×10^{-6}	2.00×10^{-5}	2.93×10^{-5}
813	2.77×10^{-7}	Not Evaluated	2.77×10^{-7}
819	3.18×10^{-6}	Not Evaluated	3.18×10^{-6}
Combined Incremental Risk			
Parcel D Impacted Sites	**Radiological Risk[a]**	**Chemical Risk[b]**	**Combined Risk**
274	3.46×10^{-6}	4.00×10^{-8}	3.50×10^{-6}
351	4.17×10^{-6}	1.00×10^{-7}	4.27×10^{-6}
351A	4.73×10^{-6}	1.00×10^{-4}	1.05×10^{-4}
366/351B	3.46×10^{-6}	1.00×10^{-5}	1.35×10^{-5}
401	1.34×10^{-6}	8.00×10^{-6}	9.34×10^{-6}
411	9.26×10^{-6}	1.00×10^{-6}	9.26×10^{-6}
813	2.77×10^{-7}	5.00×10^{-6}	5.28×10^{-6}
819	3.18×10^{-6}	5.00×10^{-6}	8.18×10^{-6}

Notes:

[a] Total excess lifetime carcinogen risk
[b] Chemical risk was taken from Revised FS for Parcel D Tables 3-2 and 3-3

Abbreviations and Acronyms:

FS – Feasibility Study

TABLE A.5-3

RESRAD RESULTS

Total Dose and Risk		
Impacted Soil Areas	**Radiological Risk[a]**	**Dose[b]**
313 Site	1.02×10^{-4}	4.66
313A Site	8.90×10^{-5}	4.04
317 Site	6.37×10^{-5}	2.93
322 Site	9.07×10^{-5}	4.11
364 Site	3.17×10^{-5}	1.50
365 Site	3.60×10^{-5}	1.67
383 Site	6.52×10^{-5}	2.98
408 Site	2.43×10^{-4}	11
Gun Mole Pier	5.08×10^{-5}	2.40
Naval Radiological Defense Laboratory Site on Mahan Street	5.08×10^{-5}	2.40
Sanitary Sewers/Storm Drains	$6,75 \times 10^{-5}$	3.09
Incremental Dose and Risk		
Impacted Soil Areas	**Radiological Risk[a]**	**Dose[b]**
313 Site	8.97×10^{-5}	4.08
313A Site	7.80×10^{-5}	3.54
317 Site	4.28×10^{-5}	1.97
322 Site	7.95×10^{-5}	3.60
364 Site	2.15×10^{-5}	1.04
365 Site	2.43×10^{-5}	1.13
383 Site	4.35×10^{-5}	1.98
408 Site	2.13×10^{-4}	9.60
Gun Mole Pier	3.42×10^{-5}	1.64
Naval Radiological Defense Laboratory Site on Mahan Street	3.42×10^{-5}	1.64
Sanitary Sewers/Storm Drains	4.54×10^{-5}	2.08

Notes:

[a] Total excess lifetime carcinogen risk
[b] millirem per year

TABLE A.5-4

COMBINED RISK FOR RADIOLOGICALLY-IMPACTED SOIL SITES

Combined Total Risk			
Parcel D Impacted Sites	**Radiological Risk[a]**	**Chemical Risk[b]**	**Combined Risk**
313 Site	1.02×10^{-4}	3.00×10^{-6}	1.05×10^{-4}
313A Site	8.90×10^{-5}	3.00×10^{-6}	9.20×10^{-5}
317 Site	6.37×10^{-5}	1.00×10^{-4}	1.64×10^{-4}
322 Site	9.07×10^{-5}	Not Evaluated	9.07×10^{-5}
364 Site	3.17×10^{-5}	1.00×10^{-4}	1.32×10^{-4}
365 Site	3.60×10^{-5}	3.00×10^{-6}	3.90×10^{-5}
383 Site	6.52×10^{-5}	1.00×10^{-5}	7.52×10^{-5}
408 Site	2.43×10^{-4}	5.00×10^{-6}	2.48×10^{-4}
Gun Mole Pier	5.08×10^{-5}	3.00×10^{-5}	8.08×10^{-5}
Naval Radiological Defense Laboratory Site on Mahan Street	5.08×10^{-5}	2.00×10^{-5}	7.08×10^{-5}
Sanitary Sewers/Storm Drains	6.75×10^{-5}	1.00×10^{-4}	1.68×10^{-4}
Combined Incremental Risk			
Parcel D Impacted Sites	**Radiological Risk[a]**	**Chemical Risk[b]**	**Combined Risk**
313 Site	8.97×10^{-5}	6.00×10^{-7}	9.03×10^{-5}
313A Site	7.80×10^{-5}	6.00×10^{-7}	7.86×10^{-5}
317 Site	4.28×10^{-5}	1.00×10^{-4}	1.43×10^{-4}
322 Site	7.95×10^{-5}	Not Evaluated	7.95×10^{-5}
364 Site	2.15×10^{-5}	1.00×10^{-4}	1.22×10^{-4}
365 Site	2.43×10^{-5}	3.00×10^{-8}	2.43×10^{-5}
383 Site	4.35×10^{-5}	2.00×10^{-6}	4.55×10^{-5}
408 Site	2.13×10^{-4}	Not Evaluated	2.13×10^{-4}
Gun Mole Pier	3.42×10^{-5}	3.00×10^{-5}	6.42×10^{-5}
Naval Radiological Defense Laboratory Site on Mahan Street	3.42×10^{-5}	Not Evaluated	3.42×10^{-5}
Sanitary Sewers/Storm Drains	4.54×10^{-5}	1.00×10^{-4}	1.45×10^{-4}

Notes:

[a] Total excess lifetime carcinogen risk
[b] Chemical risk was taken from Revised FS for Parcel D Tables 3-2 and 3-3

Abbreviations and Acronyms:

FS – Feasibility Study

TABLE A.5-5

CRITICAL EXPOSURE SCENARIO EVALUATION RESULTS

	Total Risk (excess cancer)	Pathway Fraction of Total Risk			
		External	Inhalation	Ingestion	Drinking Water
Resident (Adult)	7.23×10^{-4}	0.9907	0.0023	0.0070	0
Resident (Child)	1.84×10^{-4}	0.9874	0.0011	0.0115	0
Industrial Worker	1.79×10^{-4}	0.9902	0.0063	0.0035	0
Recreational (Adult)	5.35×10^{-5}	0.9966	0.0023	0.0011	0
Recreational (Child)	1.36×10^{-5}	0.9970	0.0011	0.0019	0
Construction Worker	7.43×10^{-6}	0.9766	0.0060	0.0174	0

TABLE A.5-6

CRITICAL ISOTOPE EVALUATION RESULTS

	Total Risk (excess cancer)	Radionuclide Fraction of Total Risk				
		Thorium-232	Cesium-137	Plutonium-239	Radium-226	Strontium-90
Resident (Adult)	7.23×10^{-4}	0.6209	0.0066	0.0011	0.3713	0.0002
Resident (Child)	1.84×10^{-4}	0.6171	0.0079	0.0013	0.3735	0.0002
Industrial Worker	1.79×10^{-4}	0.6216	0.0065	0.0018	0.3699	0.0002
Recreational (Adult)	5.35×10^{-5}	0.6213	0.0066	0.0007	0.3713	0.0001
Recreational (Child)	1.36×10^{-5}	0.6166	0.0079	0.0005	0.3748	0.0002
Construction Worker	7.43×10^{-6}	0.6175	0.0082	0.0032	0.3708	0.0003

TABLE A.5-7

CRITICAL PATHWAY EVALUATION RESULTS

	Total Risk (excess cancer)	Pathway Fraction of Total Risk			
		External	Inhalation	Ingestion	Water
Time = 0 years					
RESRAD Baseline	5.64×10^{-4}	0.9889	0.0020	0.0091	0
Revised FS for Parcel D 232 m^2	5.02×10^{-4}	0.9961	0.0015	0.0024	0
Revised FS for Parcel D 2,032 m^2	5.44×10^{-4}	0.9888	0.0018	0.0094	0
Time = 1000 years					
RESRAD Baseline	4.79×10^{-4}	0.7461	0.0021	0.0069	0.2449
Revised FS for Parcel D 232 m^2	3.43×10^{-4}	0.9323	0.0020	0.0023	0.0635
Revised FS for Parcel D 2,032 m^2	4.66×10^{-4}	0.7394	0.0018	0.0071	0.2517

Abbreviations and Acronyms:

FS – Feasibility Study
m^2 – square meter

TABLE A.5-8

COVER DEPTH AND CONTAMINATION AREA EVALUATION RESULTS

	Total Risk	Pathway Fraction of Total Risk			
	(excess cancer)	External	Inhalation	Ingestion	Drinking Water
0 inch Cover material					
RESRAD Baseline	5.64×10^{-4}	0.9889	0.0020	0.0091	0
Revised FS for Parcel D 232 m^2	5.02×10^{-4}	0.9961	0.0015	0.0024	0
Revised FS for Parcel D 2032 m^2	5.44×10^{-4}	0.9888	0.0018	0.0094	0
4 inch Cover Material					
RESRAD Baseline	1.73×10^{-4}	0.9883	0.0021	0.0096	0
Revised FS for Parcel D 232 m^2	1.71×10^{-4}	0.9963	0.0014	0.0022	0
Revised FS for Parcel D 2032 m^2	1.73×10^{-4}	0.9886	0.0018	0.0096	0
12 inch Cover Material					
RESRAD Baseline	1.89×10^{-5}	1	0	0	0
Revised FS for Parcel D 232 m^2	1.89×10^{-5}	1	0	0	0
Revised FS for Parcel D 2032 m^2	1.89×10^{-5}	1	0	0	0
24 inch Cover Material					
RESRAD Baseline	8.00×10^{-7}	1	0	0	0
Revised FS for Parcel D 232 m^2	8.00×10^{-7}	1	0	0	0
Revised FS for Parcel D 2032 m^2	8.00×10^{-7}	1	0	0	0

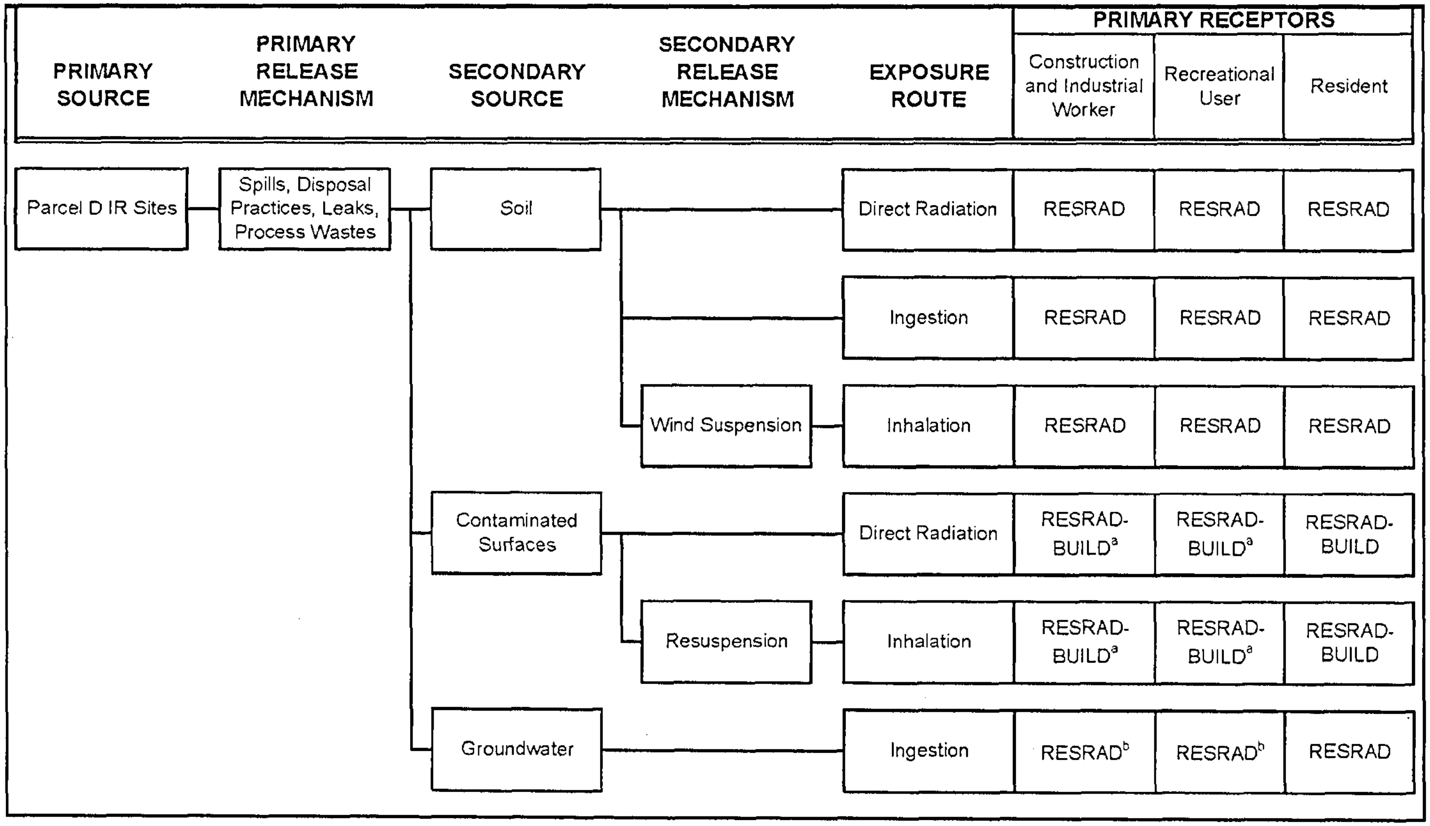
Abbreviations and Acronyms:

FS – Feasibility Study
m^2 – square meter

FIGURES

FIGURE A.3-1

CONCEPTUAL SITE MODEL



Notes:

[a] Resident scenario bounds the worker and recreational user scenarios
[b] Per agreement with Base Closure Team

Abbreviations and Acronyms:

IR – Installation Restoration
N/A – not applicable

ATTACHMENT 1

RESRAD MODELING
(Available on CD only)

ATTACHMENT 1 – RESRAD MODELING

RAW ANALYTICAL DATA IS NOT REQUIRED TO BE LOCATED AT OR NEAR THE INSTALLATION AND INFORMATION REPOSITORY.

FOR ADDITIONAL INFORMATION, CONTACT:

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NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132

TELEPHONE: (619) 532-3676
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APPENDIX B

REMEDIAL ACTION ALTERNATIVE COST SUMMARY SHEETS

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N62473-06-D-2201
CTO NO. 0006

APPENDIX B

FINAL

REMEDIAL ACTION ALTERNATIVE COST SUMMARY SHEETS
April 11, 2008

PARCEL D, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: ECSD-2201-0006-0078

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, CA 92101-8536

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

cy	cubic yard
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
ft^3	cubic feet
ICs	institutional controls
m^2	meter squared
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NRDL	Naval Radiological Defense Laboratory
O&M	operation and maintenance
ROC	radionuclide of concern
VOC	volatile organic compound

1.0 INTRODUCTION

This appendix describes each alternative and the associated components and assumptions used to develop the cost estimate used in the Addendum to the Revised Feasibility Study (FS) for Parcel D for Hunters Point Shipyard in San Francisco, California (SulTech, 2007). This appendix is organized as follows:

- Section 2.0 describes the purpose of the estimate.
- Section 3.0 presents the types of cost-estimating methods used.
- Section 4.0 summarizes the cost estimating methodology.
- Section 5.0 describes the components considered in each cost estimate.
- Section 6.0 provides assumptions used for each cost estimate.
- Section 7.0 summarizes the total costs for each alterative.
- Section 8.0 lists references used in preparing the cost estimate.

2.0 PURPOSE OF ESTIMATES

The cost estimates developed for this Radiological Addendum to the Revised FS for Parcel D (SulTech, 2007) follow the same general guidelines as for FSs. Cost estimates are developed for FSs primarily to compare remedial alternatives during the remedy selection process, and not to establish project budgets or to negotiate Superfund enforcement settlements. The cost estimate in the record of decision reflects any changes to the remedial alternatives that occur during the remedy selection process as a result of new information or public comments (U.S. Environmental Protection Agency [EPA], 2000).

Cost estimates developed during the detailed analysis phase of an FS are used to compare alternatives and to support remedy selection. The National Oil and Hazardous Substances Pollution Contingency Plan includes the following language in its description of the cost criterion for the detailed analysis and remedy selection:

> "The types of costs that shall be assessed include the following: (1) capital costs, including both direct and indirect costs; (2) Annual operations and maintenance costs; and (3) Net present values of capital and O&M [operation and maintenance] costs" (Title 40 Code of Federal Regulations § 300.430 (e)(9)(iii)(G) (EPA, 2000)

The costs presented in this appendix are for comparison only; the estimated accuracy is within the expected accuracy range of cost estimates (e.g. -30 to +50 percent), in accordance with the guidelines for developing and documenting cost estimates for FSs under the Comprehensive Environmental Response, Compensation, and Liability Act (EPA, 2000).

3.0 TYPES OF COST ESTIMATING METHODS

The cost estimates presented in this appendix are derived from the cost estimates presented in Appendix F of the Revised FS for Parcel D (SulTech, 2007). The Revised FS for Parcel D costs were developed using both detailed and parametric approaches, both accepted by EPA. These approaches are described below.

The detailed approach estimates cost on an item-by-item basis. Detailed methods typically rely on compiled sources of unit cost data for each item, taken from either a built-in database or from other sources. This method, also know as "bottom up" estimating, is used when design information is available (EPA, 2000).

The parametric approach relies on relationships between cost and design parameters. These relationships are usually either statistical or model-based. Statistically based approaches rely on scaled-up or scaled-down versions of projects where historical data on costs are available. Model-based approaches use a generic design linked to a cost database and are adjusted for site-specific information. This method, also known as "top down" estimating, is used when design information is not available (EPA, 2000).

4.0 METHODOLOGY

Cost estimates for this Radiological Addendum to the Revised FS for Parcel D were prepared in accordance with "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA, 2000). For the most part the costs were derived directly from Appendix F of the Revised FS for Parcel D (SulTech, 2007). Costs associated with activities not addressed by the Revised FS for Parcel D were estimated based on past experience with similar activities.

5.0 COMPONENTS OF COST ESTIMATE

The cost estimates for the remediation alternatives presented in the Revised FS for Parcel D included six components: grand total, total capital costs, total direct costs, annual operation and maintenance (O&M) costs, net present value of O&M costs, and contingency costs.

The cost estimates provided in this Radiological Addendum to the Revised FS for Parcel D are based on the total cost inclusive of overhead and profit presented in Appendix F of the Revised FS for Parcel D (SulTech, 2007). The main assumption is that activities common to both the Revised FS for Parcel D and this addendum will be addressed by the cost estimate provided in Appendix F of the Revised FS for Parcel D. For example, the cost associated with the Legal Controls (i.e., institutional controls [ICs], land transfer, covenant to restrict use) are applicable to both chemical and radiological alternatives. The expectation is that one set of legal controls will address both chemical and radiological concerns. The cost estimates for these types of activities will not be added to the radiological addendum alternative's cost estimate.

There are other common activities where the Revised FS for Parcel D unit cost of the activity is used to estimate the total cost of the activity in this addendum. One example is costs associated with excavation of soil. The 2005 Revised FS for Parcel D provides a cost for excavating cubic yard (cy) of soil requiring radiological screening. The total excavation cost was divided by cy to get a cost per cy. This unit cost was used to estimate the excavation costs for the alternatives proposed by this addendum.

6.0 INDIVIDUAL COST ESTIMATE ASSUMPTIONS

This section identifies the assumptions and parameters used in developing cost estimates in support of this Radiological Addendum to the Revised FS for Parcel D.

General assumptions taken from Appendix F of the Revised FS for Parcel D (SulTech, 2007) for each cost estimate are summarized below:

1. There are general project-management costs associated with each alternate native. These costs are presented as Site Wide Distributive Costs.
2. There are legal actions taken for each alternative (i.e., ICs, land transfer, covenant to restrict use). These costs are presented as Legal Controls.

The cost estimate components and specific assumption are presented for each alternative below.

6.1 COST ASSUMPTION ASSOCIATED WITH ALTERNATIVES S-1, GW-1, AND R-1: NO ACTION

Since no action means no remedial activities will take place, there are no costs associated with this alternative.

6.2 COST ASSUMPTION ASSOCIATED WITH ALTERATIVE S-2: INSTITUTIONAL CONTROLS AND MAINTAINED LANDSCAPING

Alternative S-2 proposes to apply ICs to all redevelopment blocks. The costs associated with developing and issuing ICs for radionuclides are not in addition to chemical institutional controls.

The following assumptions apply to Alternative S-2.

1. The entire Parcel D would have ICs established as well as maintained landscaping and those costs are already shown in the Revised FS for Parcel D (SulTech, 2007).

The table below provides a breakdown of the estimated cost for Alternative S-2.

Total Estimated Additional Cost for Alternative S-2	**$ 0**

6.3 COST ASSUMPTION ASSOCIATED WITH ALTERATIVE S-3: EXCAVATION, DISPOSAL, MAINTAINED LANDSCAPING, AND INSTITUTIONAL CONTROLS

Alternative S-3 proposes to excavate, screen (radiologically survey), and dispose of the soils associated with the Revised FS for Parcel D excavation of chemicals of concern, and install ICs on Parcel D.

The following assumptions apply to Alternative S-3:

1. It is assumed that all soil remediated for chemicals of concern will require a radiological survey for a total of 678 cy based on 118 cy identified for radiological screening (SulTech 2005) and 560 cy of stockpile soil (SulTech 2007).
2. It is assumed that 5 percent of the soil will be radiologically impacted and require disposal in a licensed off-site facility.
3. The extra cost for excavation of radiological soil is $2.88/cy (SulTech, 2005). The cost for soil screening for radioactivity is $65/cy. The disposal charge for radioactive waste is $11,880/disposal bin which holds 14 cy.
4. The costs for soil-maintained landscaping and ICs are already included in the Revised FS for Parcel D and are not duplicated here.

The table below provides a breakdown of the estimated cost for Alternative S-3.

Radiological soil excavation cost	$	1,953
Soil screening cost	$	44,070
Soil disposal cost	$	35,640
20% Contingency	$	16,333
Total Estimated Additional Cost for Alternative S-3	**$**	**98,000***

Notes:

* Total estimated additional cost has been rounded to the nearest thousand. The expected accuracy is within the range of -30% to +50%.

6.4 COST ASSUMPTION ASSOCIATED WITH ALTERATIVE S-4: COVERS AND INSTITUTIONAL CONTROLS

Alternative S-4 proposes to install covers over the soils that are not already covered and to install institutional controls over the entire parcel. All these costs are included in the Revised FS for Parcel D and are not duplicated here.

The table below provides a breakdown of the estimated cost for Alternative S-4.

Total Estimated Additional Cost for Alternative S-4	**$ 0**

6.5 COST ASSUMPTION ASSOCIATED WITH ALTERATIVE S-5: EXCAVATION, DISPOSAL, COVERS, AND INSTITUTIONAL CONTROLS

In addition to the Revised FS for Parcel D (SulTech, 2007) Alternative S-5 remedial actions, this radiological remedy proposes to excavate, screen (radiologically survey), and dispose of the soil that is proposed to be excavated in the Revised FS for Parcel D (SulTech, 2007). This includes all 673 cy of soil that is proposed to be excavated while digging up the chemical constituents of concern.

The following assumptions apply to Alternative S-5:

1. It is assumed that the same volume of soil is excavated for S-5 as was in S-3 and that all other costs for radiological excavation, screening, and disposal are the same.
2. The costs for soil covers and ICs are already included in the Revised FS for Parcel D and are not duplicated here.

The table below provides a breakdown of the estimated cost for Alternative S-5.

Radiological soil excavation cost	$	1,953
Soil screening cost	$	44,070
Soil disposal cost	$	35,640
20% Contingency	$	16,333
Total Estimated Additional Cost for Alternative S-5	**$**	**98,000***

Notes:

* Total estimated additional cost has been rounded to the nearest thousand. The expected accuracy is within the range of -30% to +50%.

6.6 COST ASSUMPTIONS ASSOCIATED WITH ALTERNATIVE GW-2: LONG-TERM GROUNDWATER MONITORING AND INSTITUTIONAL CONTROLS

In addition to the Revised FS for Parcel D (SulTech, 2007) Alternative GW-2 remedial actions, this radiological remedy proposes to sample the groundwater for radionuclides of concern (ROCs).

The following assumptions apply to Alternative GW-2:

1. Groundwater monitoring includes the sampling process. Radiological samples will be collected at the same time by the same personnel.
2. Assume 19 volatile organic compound (VOC) wells sampled quarterly for first 2 years, semiannually for 27 more years, and 8 samples for the last year or 1186 samples.
3. Assume 22 metals wells sampled quarterly for first 2 years, semiannually for next 27 years, and 8 samples for the last year or 1372 samples.

4. Radiological analysis of groundwater is assumed to be $200 per sample.

5. Assume an annual discount factor equal to $1/(1+i)^t$: where i = 0.031 and t = year (that is, the present value of a dollar paid in year t at 3.1%)

The table below provides a breakdown of the estimated cost for Alternative GW-2.

VOC well samples (present value costs)	$	159,200
Metal well samples (present value costs)	$	184,200
20% Contingency	$	68,680
***Total Estimated Additional Cost for Alternative GW-2**	$	**412,000***

Notes:

* Total estimated additional cost has been rounded to the nearest thousand. The expected accuracy is within the range of -30% to +50%.

6.7 COST ASSUMPTIONS ASSOCIATED WITH ALTERNATIVES GW-3A AND GW-3B: IN-SITU TREATMENT OF VOCS, GROUNDWATER MONITORING FOR METALS AND VOCS, AND INSTITUTIONAL CONTROLS

In addition to the Revised FS for Parcel D (SulTech, 2007) Alternative GW-3A and GW-3B remedial actions, this radiological remedy proposes to sample the groundwater for ROCs. Alternatives GW-3A and GW-3B have no additional remedies for ROCs.

The following assumptions apply to Alternatives GW-3A and GW-3B:

1. Groundwater monitoring includes the sampling process. Radiological samples will be collected at the same time by the same personnel.
2. Assume 22 wells sampled quarterly first year and annually thereafter for 30 more years for a total of 748 samples
3. Radiological analysis of groundwater is assumed to be $200 per sample.
4. Assume an annual discount factor equal to $1/(1+i)^t$: where i = 0.031 and t = year (that is, the present value of a dollar paid in year t at 3.1%)

The table below provides a breakdown of the estimated cost for Alternatives GW-3 and GW-3B.

Groundwater samples(present value costs)	$	99,649
20% Contingency	$	19,930
***Total Estimated Additional Cost for Alternatives GW-3A/GW-3B**	$	**120,000***

Notes:

* Total estimated additional cost has been rounded to the nearest thousand. The expected accuracy is within the range of -30% to +50%.

6.8 COST ASSUMPTIONS ASSOCIATED WITH ALTERNATIVES GW-4A AND GW-4B: IN-SITU TREATMENT FOR VOCS AND METALS, GROUNDWATER MONITORING, AND INSTITUTIONAL CONTROLS

In addition to the Revised FS for Parcel D (SulTech, 2007) Alternatives GW-4A and GW-4B remedial actions, this radiological remedy proposes to sample the groundwater for ROCs. Alternatives GW-4A and GW-4B have no additional remedies for ROCs.

The following assumptions apply to Alternatives GW-4A and GW-4B:

1. Groundwater monitoring includes the sampling process. Radiological samples will be collected at the same time by the same personnel.
2. Assume 41 wells sampled quarterly the first two years and annually thereafter for 28 more years for a total of 1500 samples
3. Radiological analysis of groundwater is assumed to be $200 per sample.
4. Assume an annual discount factor equal to $1/(1+i)^t$: where $i = 0.031$ and $t =$ year (that is, the present value of a dollar paid in year t at 3.1%)

The table below provides a breakdown of the estimated cost for Alternatives GW-4A and GW-4B.

Groundwater samples(present value costs)	$	210,255
20% Contingency	$	42,051
***Total Estimated Cost for Alternatives GW-4A/GW-4B**	$	**252,000***

Notes:

* Total estimated cost has been rounded to the nearest thousand. The expected accuracy is within the range of -30% to +50%.

6.9 COST ASSUMPTION ASSOCIATED WITH ALTERATIVE R-2: SURVEY, DECONTAMINATION, EXCAVATION, DISPOSAL, AND RELEASE

Alternative R-2 consists of decontamination of radiologically-impacted buildings and dismantlement if necessary. Surveys of buildings, soils of former building sites and outdoor areas, trenches resulting from sewer and storm line removal, and soils of remediated storm drains and sanitary sewers would be conducted to meet the remedial action objectives.

The following assumptions apply to Alternative R-2:

1. Each building (274, 351, 351A, 364, 365, 366/351B, 401, 408, 411, 813, and 819) will be divided into 31 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (Department of Defense et al., 2000) survey units. Each former building site (313, 313A, 317, 322, and 383 area) will be divided into three survey units. The cost for developing the survey plans, performing the survey, and drafting

the report is $6,500 per survey unit. This cost is based on the San Francisco "49ers" Parcel D proposal summary and results in an estimated cost of $1,969,500.

2. Each building (274, 351, 351A, 364, 365, 366/351B (considered two separate buildings), 401, and 411) is assumed to generate one disposal bin of material (e.g., flooring, ventilation piping, etc.) from dismantlement activities. Building 408 is assumed to generate 8 bins of waste due to firebrick removal and dismantlement activities and Building 364 is expected to generate 3 waste bins of material. Using a disposal cost of $11,880 per bin with the total cost $213,840.
3. Each former building site (313, 313A, 317, 322, 364, 365, 383 area, 408) survey unit is assumed to have two elevated areas resulting in the generation of 10 cubic feet (ft^3) of radiologically-impacted soil from each survey unit. The total volume of radiologically-impacted soil is estimated to be 240 ft^3 (8.89 cy). The cost of disposal is assumed to be $11,880 per bin, and based on 14 cy of soil per bin the total disposal cost is estimated to be $11,880.
4. The Gun Mole Pier and NRDL Site on Mahan Street will be divided into 1,000 square meter (m^2) survey units. The surface area of the two sites is approximately 76,473 m^2 (823,175 square feet) resulting in 77 survey units. The cost of performing the survey in each survey unit is assumed to be $6,500. This cost is based on the San Francisco "49ers" Parcel D proposal summary and results in an estimated cost of $500,500. Each survey unit is assumed to have two elevated areas resulting in the generation of 150 ft^3 of radiologically-impacted soil from each survey unit. The total volume of radiologically-impacted soil is estimated to be 11,550 ft^3 (428 cy). The cost of disposal is assumed to be $11,880 per bin, and based on 14 cy of soil per bin the total disposal cost is estimated to be $368,280.
5. Removal of the Parcel D sewer and storm drain systems is estimated to result in 60,000 cy of material to be excavated at an estimated cost of $330 per cy of material excavated. This results in a total excavation cost of $19,800,000.
6. It is assumed that 5 percent of the material excavated during the Parcel D sewer and storm drain system removal will be radiologically-impacted resulting in approximately 3,000 cy of material. The cost of disposal is assumed to be $11,880 per bin, and based on 14 cy of soil per bin the total disposal cost is estimated to be $2,554,200. Note this does not include cost associated with disposal of Comprehensive Environmental Response, Compensation, and Liability Act-impacted materials.

The table below provides a breakdown of the estimated cost for Alternative R-2.

Impacted Parcel D Building and former building site Surveys/Release	$ 1,969,500
Radiological soil screening and waste disposal for building and building sites	$ 213,840
Gun Mole Pier and NRDL Site Surveys and Remediation	$ 868,780
Parcel D sewer and storm drain removal and disposal	$ 22,354,200
20% Contingency	$ 5,081,264
***Total Estimated Cost for Alternative R-2**	**$ 30,487,584***

Notes:

* Total estimated cost has been rounded to the nearest thousand. The expected accuracy is within the range of -30% to +50%.

7.0 SUMMARY

The total cost for each alternative is summarized below.

Alternative Name and Description	Estimated Cost[a]
Alternative S-1 – No Action	$0
Alternative S-2 – Institutional Controls and Maintained Landscaping	$0[b]
Alternative S-3 – Excavation, Disposal, Maintained Landscaping, and Institutional Controls	$98,000[b]
Alternative S-4 – Covers and Institutional Controls	$0[b]
Alternative S-5 – Excavation, Disposal, Covers, and Institutional Controls	$98,000[b]
Alternative GW-1 – No Action	$0
Alternative GW-2 – Long-Term Monitoring of Groundwater and Institutional Controls	$412,000[b]
Alternatives GW-3A and GW-3B – In-Situ Treatment for VOCs, Groundwater Monitoring for VOCs and Metals, and Institutional Controls	$120,000[b]
Alternatives GW-4A and GW-4B – In-Situ Treatment for VOCs and Metals, Groundwater Monitoring for VOCs and Metals, and Institutional Controls	$252,000[b]
Alternative R-1 – No Action	$0
Alternative R-2 – Survey, Decontamination, Disposal, and Release	$30,487,584

Notes:

[a] Rounded to the nearest thousand dollars.
[b] Additional cost.

Abbreviations and Acronyms:

VOC – volatile organic compound

8.0 REFERENCES

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APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N62473-06-D-2201
CTO NO. 0006

APPENDIX C

FINAL

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

April 11, 2008

PARCEL D, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: ECSD-2201-0006-0078

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, CA 92101-8536

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ABBREVIATIONS AND ACRONYMS

§	Section
AEA	Atomic Energy Act
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm	centimeter
COC	constituent of concern
DERP	Defense Environmental Restoration Program
DOE	Department of Energy
DON	Department of the Navy
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
HPS	Hunters Point Shipyard
LLRW	low-level radioactive waste
LLWPA	Low-Level Radioactive Waste Policy Act
IC	institutional control
MCL	Maximum Contaminant Level
mrem	millirem
mrem/y	millirem per year
mSv	millisievert
NARM	naturally occurring and accelerator-produced radioactive material
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NORM	naturally occurring radioactive material
NRC	Nuclear Regulatory Commission
NRDL	Naval Radiological Defense Laboratory
PAH	polynuclear aromatic hydrocarbons

ABBREVIATIONS AND ACRONYMS
(Continued)

pCi/g	picocurie per gram
^{226}Ra	radium-226
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RG	regulatory guideline
ROC	radionuclide of concern
ROD	Record of Decision
TBC	to be considered
TEDE	total effective dose equivalent
TENORM	technically enhanced naturally occurring radioactive material
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	United States Code
VOC	volatile organic carbon

1.0 PURPOSE

This appendix identifies and evaluates potential federal and State of California applicable or relevant and appropriate requirements (ARARs), based on regulations, requirements, and guidance, and sets forth the Department of the Navy (DON) determinations on those potential ARARs for each remedial action alternative retained for detailed analysis in this radiological addendum to the Revised Feasibility Study (FS) for Parcel D, San Francisco, California (SulTech, 2007).

This evaluation includes an initial determination of whether the potential ARARs actually qualify as ARARs, and a comparison for stringency between the federal and state regulations to identify the controlling ARARs. The identification of ARARs is an iterative process. The final determination of ARARs will be made by the DON in the Record of Decision (ROD) or Action Memorandum, after public review, as part of the response action selection process.

1.1 SUMMARY OF CERCLA AND NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTINGENCY PLAN REQUIREMENTS

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, 42 United States Code [U.S.C.], Section [§] 9621[d]), as amended, states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are will suited to the conditions of the site (U.S. Environmental Protection Agency (EPA), 1988). A requirement must be determined to be both relevant and appropriate in order to be considered an ARAR. The criteria for determining relevance and appropriateness are listed in 40 Code of Federal Regulations (CFR), § 300.400(g)(2) and include the following:

- The purpose of the requirement and the purpose of the CERCLA action
- The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site
- The substances regulated by the requirement and the substances found at the CERCLA site
- The actions or activities regulated by the requirement and the response action contemplated at the CERCLA site
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site
- The type of place regulated and the type of place affected by the release or CERCLA action
- The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site

According to CERCLA ARARs guidance (EPA, 1988), a requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involve a two-part analysis: first, a determination whether a given requirement is applicable, and second, when the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA, 1988).

Tables included in this appendix present each potential ARAR with an initial determination of ARAR status (i.e., applicable, relevant and appropriate, to be considered, or not an ARAR). For the determination of relevance and appropriateness, the pertinent criteria were examined to determine whether the requirements addressed problems or situations sufficiently similar to the circumstances of the release of response action contemplated, and whether the requirement was well suited to the site. A negative determination of relevance and appropriateness indicates that the requirement did not meet the pertinent criteria. Negative determinations are documented in the tables of this appendix.

To qualify as a state ARAR under CERCLA and National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a state requirement must be:

- A state law or regulation
- An environmental or facility siting law or regulation
- Promulgated (of general applicability and legally enforceable)
- Substantive (not procedural or administrative)
- More stringent than federal requirements

- Identified in a timely manner
- Consistently applied

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered ARARs. Permits are considered procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or non-environmental, including permit requirements, are not considered ARARs. CERCLA 121(e)(1), Title 42 U.S.C., Section 9621(e)(1), states, "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term "on-site" is defined for this ARAR discussion as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (40 CFR § 300.5).

Non-promulgated advisories or guidance issued by the federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful, and are "to be considered" (TBC). TBC requirements complement ARARs but do not override them (40 CFR § 300.4700[g][3]). They are useful for guiding decisions regarding cleanup goals or methodologies when regulatory standards are not available.

Pursuant to EPA guidance (EPA, 1988), ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to aid in identifying ARARs; some ARARs do not fall precisely into one group or another. ARARs are identified on a site-specific basis for remedial actions where CERCLA authority is the basis for cleanup.

As the lead federal agency, the DON has primary responsibility for identifying federal ARARs at Hunters Point Shipyard (HPS) Parcel D. Potential federal ARARs are discussed in Section 1.2.2. Pursuant to the definition of on-site in 40 CFR § 300.5, the on-site areas that are part of this action include all of Parcel D.

Identification of potential state ARARs was initiated through DON requests that the California Department of Toxic Substances Control (DTSC), the Regional Water Quality Control Board (Water Board, San Francisco Bay), and the San Francisco Bay Conservation and Development Commission identify potential state ARARs. Potential state ARARs that have been identified for Parcel D are discussed below.

1.2 DESCRIPTION OF METHODOLOGY

The process of identifying and evaluating potential federal and state ARARs is described in this subsection.

1.2.1 General

As the lead federal agency, the DON has primary responsibility for identification of potential ARARs for Parcel D. In preparing this ARARs analysis, the DON undertook the following measures, consistent with CERCLA and the NCP:

- Identified potential federal ARARs for each response action alternative in this Radiological Addendum to the Revised FS for Parcel D, taking into account site-specific information for Parcel D.
- Reviewed potential state ARARs identified by the state to determine whether they satisfied CERCLA and NCP criteria that must be met to constitute state ARARs.
- Evaluated and compared federal ARARs and their state counterparts to determine whether state ARARs were more stringent than the federal ARARs or were in addition to the federally required actions.
- Reached a conclusion as to which federal and state ARARs were the most stringent or "controlling" for each alternative.

Section 4.1 of this Radiological Addendum to the FS for Parcel D discusses and presents the remedial action objectives (RAOs) for the remedial actions at Parcel D. The RAOs for the radionuclides of concern (ROCs) are identified below:

- Prevent or reduce exposure to ROCs in impacted buildings and structures, soils of former building sites, fill areas, and soils of remediated storm drains and sanitary sewers above cleanup goals developed and shown in Table 3-2 of this Radiological Addendum to the Revised FS for Parcel D for the following pathways:
  - Direct exposure to gamma radiation
  - Ingestion of soils
  - Inhalation of soils

The alternatives for performing the RAOs that are evaluated in this Radiological Addendum to the Revised FS for Parcel D are:

- Alternative S-1 – No Action
- Alternative S-2 –Institutional Controls (ICs) and Maintained Landscaping
- Alternative S-3 – Excavation, Disposal, Maintained Landscaping, and ICs
- Alternative S-4 – Covers and ICs
- Alternative S-5 – Excavation, Disposal, Covers, and ICs
- Alternative GW-1 – No Action
- Alternative GW-2 – Long-term Monitoring of Groundwater and ICs
- Alternatives GW-3A and GW-3B – In-situ Treatment for VOCs, Groundwater Monitoring for Metals and VOCs, and Institutional Controls

- Alternatives GW-4A and GW-4B – In-situ Treatment for VOCs and Metals, Groundwater Monitoring, and ICs
- Alternative R-1 – No Action
- Alternative R-2 – Survey, Decontamination, Excavation, Disposal, and Release

1.2.2 Identifying and Evaluating Federal ARARs

The DON is responsible for identifying federal ARARs as the lead federal agency under CERCLA and the NCP. The final determination of federal ARARs will be made when the DON issues the ROD. The federal government implements a number of federal environmental statutes that are the source of potential federal ARARs, either in the form of the statutes or regulations. Examples include the Resource Conservation and Recovery Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act, and their implementing regulations.

The components of the proposed response action were reviewed to determine if they were applicable or relevant and appropriate using the CERCLA and NCP criteria and procedures for ARARs identification by lead federal agencies.

EPA guidance recommends that the lead federal agency consult with the state when identifying state ARARs for remedial actions (EPA, 1988). In essence, the CERCLA and NCP requirements at 40 CFR § 300.515 for remedial actions provide that the lead federal agency request that the state identify chemical-specific and location-specific state ARARs upon completion of site characterization. The requirements also provide that the lead federal agency request identification of all categories of state ARARs (chemical-, location-, and action-specific) upon completion of identification of remedial alternatives for detailed analysis. As part of the agreement, the DON is responsible for identifying potential federal ARARs, and DTSC is responsible for coordinating with state and local governmental agencies and identifying potential state ARARs.

2.0 CHEMICAL-SPECIFIC ARARs

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in establishment of a cleanup goal. Many potential ARARs associated with particular response alternatives (such as closure or discharge) can be characterized as action-specific but include numerical values or methodologies to establish them so they fit in both categories (chemical- and action-specific).

This section presents ARARs addressing numerical values for the cleanup of radiologically contaminated equipment, structures, air, and soils. Potential federal and state chemical-specific ARARs are summarized in Tables C.2-1 and C.2-2 at the end of this appendix.

2.1 POTENTIAL FEDERAL AND CALIFORNIA STATE CHEMICAL-SPECIFIC ARARS

2.1.1 Radioactive Waste Categorization

Low-Level Radioactive Waste

The definition of low-level (radioactive) waste (LLRW) is found within Nuclear Regulatory Commission (NRC) licensing regulations. It encompasses materials that are slightly above natural radiation background levels to highly radioactive materials that require extreme caution when handling. The term "low-level radioactive waste" means radioactive material that: 1) is not high-level radioactive waste, spent nuclear fuel, or by-product material (the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content); and 2) the NRC classifies as low-level radioactive waste (LLRW Policy Act at Title 42 U.S.C. §§ 2021[b][9] and 2014[e][2]).

Low-level radioactive waste includes items with radioactive material or materials that have become radioactive through exposure to neutron radiation. This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment and tools, luminous dials (containing tritium or other non-radium radionuclides), medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues. The radioactivity can range from just above naturally occurring background levels to very high levels. LLRW does not include naturally occurring and accelerator-produced radioactive material (see below).

Naturally Occurring and Accelerator-Produced Radioactive Waste

Naturally occurring and accelerator-produced radioactive material (NARM) is a broad category that includes accelerator-produced radioactive material and naturally occurring radioactive material (NORM), but does not include source, special nuclear, or by-product material. NORM is a subset of NARM. Accelerator-produced radioactive materials (the "A" in NARM) include wastes generated by accelerators used in subatomic particle physics research.

The term technically enhanced NORM (TENORM) refers to NORM whose radioactivity has been enhanced (i.e., NORM whose radionuclide concentrations are either increased or redistributed compared to typical background levels either naturally or as the result of human intervention or processes). Examples are exploration and production wastes from the oil and natural gas industries and phosphate slag piles from the phosphate mining industry.

Currently, no federal regulations specifically control NARM (NRC regulations do not include NARM at this time). However, numerous federal laws do regulate parts of the NORM/TENORM industry. An example is the maximum contaminant level (MCL) for radium.

2.1.2 Authority and Responsibility for Radioactive Waste

The Atomic Energy Act (AEA), as amended, is the basic law governing production, use, ownership, disposal of, and liability for radioactive materials in the United States. A number of laws also specify radioactive-waste-management procedures and authorities. In 1980, Congress passed the Low-Level Radioactive Waste Policy Act (LLWPA; amended in 1985, LLWPA Amendment) which stipulated disposal of non-Department of Energy (DOE) LLRW a responsibility of the states and the disposal of commercial transuranic waste and "greater than Class C" LLRW (see Title 10 CFR § 61.55 for waste categories) a federal responsibility. According to these laws, the EPA must set radiation protection standards for disposal of LLRW, supplementing standards set by NRC. However, the EPA has not as yet established this regulation. Recent amendments to the AEA, in the Energy Policy Act of 2005, have brought radium-226 (^{226}radium), NARM, and NORM under the jurisdiction of the NRC.

In California, regulation of NARM disposal currently rests with the State of California as part of its authority as an Agreement State for ensuring the protection of public health and safety. Even though the State has the authority, the state regulations must be more stringent than the federal ARARs to be potential ARARs.

Responsibilities for management of nuclear materials, including radioactive wastes, are defined in the above-mentioned laws passed by Congress. These laws are administered by government agencies that codify the details in the CFR, in guidance documents, and in internal orders. Responsibilities for action, monitoring, enforcement, and setting standards are divided between several agencies. DOE, EPA, NRC, and the Department of Transportation are all involved in different aspects of radioactive waste management for DOE projects on the federal level. Management of wastes from other generators involves the same agencies and includes DOE for high-level waste and greater-than-Class-C LLRW.

Using AEA authority, the NRC and DOE regulate mixed waste with regard to radiation safety. Using Resource Conservation and Recovery Act (RCRA) authority, EPA regulates mixed waste with regard to hazardous waste safety. Once a waste is determined to be a mixed waste, the DON must comply with both AEA and RCRA statutes and regulations. The requirements of RCRA and AEA are generally consistent and compatible.

California Radioactive Waste Categorization

State radioactive waste standards are provided at California Code of Regulations (CCR) Title 17 § 30253. The state standards incorporate most of 10 CFR § 20 by reference but they do exclude certain key NRC requirements including the license termination provisions of 10 CFR § 20.1403 and 20.1404 discussed below. In addition, the State requirements regulate a broader category of radioactive wastes, including NARM.

The contaminated soil at Parcel D has been determined to be NARM. Substantive federal requirements of the NRC are potentially relevant and appropriate for the NARM at Parcel D since HPS is not an NRC licensee. Although the state requirements may be applicable, the state requirements are not more stringent than federal ARARs, and hence are not potential ARARs.

NRC Licensing Regulations for Land Disposal of Radioactive Waste

The requirements to obtain a license are not potential ARARs since they are not substantive. The DON investigates and responds to hazardous substances released from its sites in a remedial action selected pursuant to its authority under Section 104 of CERCLA as amended, the Defense Environmental Restoration Program (DERP) (10 U.S.C. § 2701, et seq.), and federal Executive Order 12580 as amended. The DON's CERCLA remedial action selection decision will address all hazardous substances released at the site, including radionuclides, and will be memorialized in a ROD.

Permits, licenses or similar regulatory approvals are not required for a CERCLA response action. More specifically, Section 121(e)(1) of CERCLA states, "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term on-site is defined as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (40 CFR § 300.5).

NRC Licensing Requirements for Land Disposal of Radioactive Waste (10 CFR § 61, Subparts C and D) are not potentially applicable since the site is not an NRC-licensed site. Obtaining a license is not a potential ARAR since CERCLA actions are exempt from procedural and administrative provisions and are exempt from having to obtain a permit of any kind. Additionally, the substantive performance objectives for the land disposal of LLRW are not relevant and appropriate since no radioactive waste will be left in Parcel D. See Section 3.2.4.4

for the radioactive waste classification discussion. The requirements at 10 CFR § 61.40 state that land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposure to humans is within the limits established in the performance objectives in 10 CFR § 61.41-61.44. The requirements at 10 CFR § 61.41 are discussed as chemical-specific requirements. The requirements of 10 CFR § 61.42 state that design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active ICs over the disposal site are removed.

The NRC has standards for protection against radiation for waste disposal at 10 CFR §§ 20.2001–20.2006. Under 10 CFR § 20.2001(a) disposal of regulated material is allowed only by: 1) transfer to an authorized recipient; 2) by decay in storage; or 3) by release in effluents within the limits in § 20.1301 or as authorized under §§ 20.2002, 20.2003, or 20.2004 (described below).

The substantive provisions of 10 CFR § 20.2002(d) that require analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in § 20 are not potentially relevant and appropriate since HPS is not an NRC licensee nor is the Gun Mole Pier or Naval Radiological Defense Laboratory (NRDL) Site on Mahan Street a licensed disposal facility.

NRC Standards for Protection Against Radiation

The substantive radiological criteria for termination of a license for an existing NRC-licensed, radioactive waste-contaminated site when future unrestricted use is proposed are found at 10 CFR § 20.1402. These regulations provide that a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from (i.e., above) background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 millirems (mrem) (or 0.25 milliSievert [mSv]) per year, including that contributed from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are ALARA. The TEDE is the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). These criteria apply only to ancillary surface facilities that support radioactive waste disposal activities regulated as discussed earlier, under 10 CFR § 61.

The radium in soil at Parcel D is similar to radioactive waste regulated at an NRC site. The substantive provisions of 10 CFR § 20.1402 are potentially relevant and appropriate for an unrestricted land-use scenario at Parcel D (all Parcel D-impacted sites). This standard is less stringent than the risk based remediation goal for this response action.

NRC Radiation Dose Limits for Individual Members of the Public

Radiation dose limits for the public are required in the substantive provisions of 10 CFR § 20.1301. This section requires that the TEDE to individual members of public not exceed 100 millirems per year (mrem/y) from licensed operations.

NRC licenses the following activities:

- Construction, operation, and decommissioning of commercial reactors and fuel cycle facilities
- Possession, use, processing, exporting, and certain aspects of transporting nuclear materials and waste
- Siting, design, construction, operations, and closure of waste disposal sites

The proposed Alternatives S-1, S-2, S-3, S-4, and S-5 for Parcel D do not include leaving radioactive waste on site. Since the proposed action is not similar to the regulated activity of closure of waste disposal sites (not an NRC license) and the action is addressing similar wastes as those regulated, the substantive radiation dose limits for the public at 10 CFR § 20.1301 are not potentially relevant and appropriate.

Uranium Mill Tailings Radiation Control Act

The Uranium Mill Tailings Radiation Control Act (UMTRCA) standards are not applicable to HPS because it is not a mill site to which the UMTRCA standards specifically apply. Specific UMTRCA requirements are therefore evaluated as to whether they are potentially relevant and appropriate for the remedial action at HPS.

Substantive requirements for cleanup of radioactive contaminants are found in UMTRCA standards for land and buildings contaminated with residual radioactive materials from inactive uranium processing sites. Dose limits for ^{226}Ra in soil are found at 40 CFR §§ 192.12(a), 192.32(b)(2), and 192.41, which state that as a result of residual radioactive materials from any designated processing site:

(a) The concentration of ^{226}radium in land averaged over any area of 100 square meters shall not exceed the background level by more than,

(1) 5 picocuries per gram (pCi/g), averaged over the first 15 centimeters (cm) of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil, more than 15 cm below the surface.

The substantive provisions of 40 CFR §§ 192.12(a)(1), 192.32(b)(2), and 192.41 are not determined to be potentially relevant and appropriate for surface contamination at Parcel D Gun

Mole Pier and the NRDL Site on Mahan Street since the radioactive contaminants are not proposed to be left in Parcel D.

The criteria at 10 CFR § 40 Appendix A, Part I, Criterion 6(6) provide a benchmark approach for setting radionuclide cleanup levels as a supplement to 40 CFR § 192.

The substantive provisions of 40 CFR §§ 192.12(b)(1) and 192.41(b) are not determined to be potentially relevant and appropriate to the building structures at Parcel D because radium contamination is not proposed to be left in buildings.

A concentration limit for gamma radiation in buildings at inactive uranium processing sites designated for remedial action is provided at 40 CFR § 192.12(b) (2). This requirement states that the level of gamma radiation in any occupied or habitable building shall not exceed the background level by more than 20 microroentgens per hour.

NESHAPS Requirements for Radionuclides

Emission limitations are provided under National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for facilities owned or operated by the DOE that emit radionuclides other than radon-222 and radon-220 into the air. Under 40 CFR § 61 Subpart H 61.92, emissions of radionuclides into the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/y.

Under 40 CFR § 61 Subpart I 61.102, emissions of iodine into the ambient air from a facility regulated under this subpart shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 3 mrem/y. Similarly, emissions of all radionuclides (including iodine), shall not exceed amounts that would cause an effective dose equivalent of 10 mrem/y.

These requirements are limited to the cleanup action at a CERCLA site. Part II of the CERCLA Compliance with Other Laws Manual states:

> "...these subparts (Subparts H and I) would not be applicable or relevant and appropriate for airborne emissions from residual contamination after cleanup, when the facility is no longer in operation (the standards were developed to limit radiation doses caused by operations that yield a beneficial product)."

Therefore, after removal or handling of radionuclide waste at a site, the requirements under Subparts H and I of 40 CFR § 61 are not ARARs.

Remedial Action with Release of the Site for Restricted Use

At all sites the remedial action conducted by the DON (Alternatives S-2, S-3, S-4, and S-5) will not result in containment of potential residual LLRW. This type of remedial action will not include one or both of the following general actions for radioactive materials:

- *Capping and Land-use Controls:* This remedial action generally includes construction of cap with minimum disturbance of the waste or contaminated soil. Additionally, institutional and engineering controls are implemented to protect the integrity of the cap, human health, and the environment under restricted use.
- *Partial Removal/Remediation of Contaminated Media:* This remedial action generally includes removal or remediation of the radioactive media to the levels protective of human health under restricted use. In addition, land use and engineering controls are implemented to protect human health and the environment.

Capping and Institutional Controls

Land use restrictions for radiological constituents are not applicable as no radiological contamination above the release criteria shall be left in place at Parcel D. Any ICs identified for soils will be done so for chemical constituents, and are subject to the restricted release requirements generally applicable to land-use restrictions specified in Part 4.2.3.1 of the Revised FS for Parcel D.

Any excavation into a soil cover/cap selected as a remedy for chemical constituents in Parcel D must be approved by the Federal Facility Agreement (FFA) Signatories and the California Department of Health Services as provided by the Parcel D RMP. The integrity of the cover/cap must be restored upon completion of excavation as provided by the Parcel D RMP and approved by the FFA Signatories.

Remedial Action with Release of the Site for Unrestricted Radiological Use

This remedial action alternative is conducted to release a site for unrestricted reuse. The potential federal ARARs are contained in NRC's Radiological Criteria for Unrestricted Use at 10 CFR § 20.1402. The substantive provisions of the following regulation are potential ARARs:

> "A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable for background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 millirems per year including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."

3.0 LOCATION-SPECIFIC ARARs

Potential location-specific ARARs are identified and discussed in this section and are presented in Table C.3-1, included at the end of this appendix.

3.1 SUMMARY OF LOCATION-SPECIFIC ARARS

Eight protected resource categories are associated with location-specific ARARs: 1) cultural resources, 2) wetlands protection, 3) floodplain management, 4) hydrological resources, 5) biological resources, 6) coastal resources, 7) other natural resources, and 8) geologic characteristics. Cultural and coastal resources are the only categories of protected resources affected by the radiological response actions at Parcel D.

3.1.1 Potential Federal and State Location-specific ARARS

The only federal and State ARAR that is not specified in the Revised FS for Parcel D (SulTech, 2007) is the following:

> 16 U.S.C., Sections 470-470x-6, 36 CFR § 800, 40 CFR § 6.301(b) require that action preserve historic properties, planning of action to minimize harm to properties listed on or eligible for listing on the national Register of Historic Places. The cultural site that has been suggested as a potential historical site is the Gun Mole Pier gantry crane.

4.0 ACTION-SPECIFIC ARARs

The DON is evaluating several alternatives for the remediation of radionuclides from Parcel D. The requirements determined to be pertinent to each alternative being evaluated for the Parcel D action are discussed in this section. Table C.4-1, included at the end of this appendix, presents the potential action-specific ARARs.

Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities. These requirements are triggered by the specific remedial activities conducted at the site and indicate how a selected remedial alternative should be achieved. The DON has identified potential action-specific ARARs for the soil and impacted Parcel D buildings and structures alternatives evaluated in this radiological addendum to the Revised FS for Parcel D.

4.1 REMEDIAL ALTERNATIVES FOR RADIONUCLIDES

The Revised FS for Parcel D identifies five soil and three groundwater alternatives for impacted sites in Parcel D. This addendum presents three alternatives for radiologically-impacted sites. Parcel D alternatives are described in the following sections.

4.1.1 Alternative S-1, GW-1, and R-1 – No Action

There is no need to identify action-specific ARARs for the no-action alternative because ARARs apply to "any removal or remedial action conducted entirely "on-site" and "no action" is not a removal or remedial action.

4.1.2 Alternative S-2 – Institutional Controls and Maintained Landscaping

Alternative S-2 consists of ICs and maintained landscaping that, together will meet all applicable or relevant and appropriate requirements and remedial action objectives. The institutional controls include access restrictions and covenants to restrict use of property that will be implemented parcel-wide for all of the redevelopment blocks. The maintained landscaping would prevent potential exposure to asbestos (that may be present in surface soil and transported by wind erosion) that would not be addressed by institutional controls alone.

4.1.2.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs that are applicable for Alternative S-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007). However, the substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for the remediation of radiologically-impacted sites:

- Standards for Protection Against Radiation (10 CFR §§ 20.1402)

4.1.2.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative S-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.2.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative S-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.3 Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls

Alternative S-3 consists of soil excavation and off-site disposal, maintained landscaping, and ICs similar to those of Alternative S-2. In areas where lead and polynuclear aromatic hydrocarbon (PAHs) are constituents of concern (COCs), soil above remediation goals will be excavated and disposed of at an off-site facility. This alternative will provide a more permanent remedy to reduce the volume and toxicity of contaminants where excavation is feasible, as described in the Revised FS for Parcel D (SulTech, 2007). Areas of bare or minimally vegetated soil that have been disturbed by excavation or construction activities and not restored with a cover will be covered by maintained landscaping as described in Alternative S-2.

4.1.3.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs that are applicable for Alternative S-3 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007). However, the substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for the remediation of radiologically-impacted sites:

- Standards for Protection Against Radiation (10 CFR §§ 20.1402)

4.1.3.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative S-3 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.3.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative S-3 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.4 Alternative S-4 – Covers and Institutional Controls

Alternative S-4 consists of covers to remove the exposure pathway to soil contaminants and ICs similar to Alternatives S-2 and S-3. Covers included in this alternative may include new covers and existing or future building footprints, roads, parking lots, and maintained landscaping. ICs are included in this alternative for both short-term and long-term mitigation of risk exposure. In addition to ICs similar to those required for Alternative S-2, institutional controls will also be included that would require maintenance of covers.

4.1.4.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs that are applicable for Alternative S-4 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007). However, the substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for the remediation of radiologically-impacted sites:

- Standards for Protection Against Radiation (10 CFR §§ 20.1402)

4.1.4.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative S-4 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.4.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative S-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.5 Alternative S-5 – Excavation, Disposal, Covers, and Institutional Controls

Alternative S-5 consists of a combination of soil excavation, disposal, covers, and ICs. This alternative was developed as a combined alternative to 1) remove and dispose of lead and PAHs as described in Alternative S-3, 2) implement and maintain block-wide covers as described in Alternative S-4, and 3) implement parcel-wide ICs as described in Alternative S-2.

4.1.5.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs that are applicable for Alternative S-5 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007). However, the substantive provisions of the following potential radiation-specific requirements were identified as potentially relevant and appropriate for the remediation of radiologically-impacted sites:

- Standards for Protection Against Radiation (10 CFR §§ 20.1402)

4.1.5.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative S-5 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.5.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative S-5 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.6 Alternative GW-2: Long-term Monitoring of Groundwater and Institutional Controls

Alternative GW-2 consists of groundwater monitoring and ICs. This alternative was developed as a method for monitoring contaminants present at low concentrations in groundwater. Additionally, groundwater monitoring would be used to confirm site conditions and ensure that, over time, the potential exposure pathways remain incomplete. ICs are also included in this alternative to effectively manage risk by preventing exposure and use of the groundwater. Groundwater monitoring for the ROCs would be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.

4.1.6.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs for Alternative GW-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.6.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative GW-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.6.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative GW-2 that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.7 Alternatives GW-3A and GW-3B: In-Situ Treatment for VOCs, Groundwater Monitoring for Metals and VOCs, and Institutional Controls

Alternatives GW-3A and GW-3B consist of in-situ treatment of the volatile organic compounds (VOC) contaminant plumes. GW-3A and GW-3B do not treat metals in groundwater. These alternatives also include groundwater monitoring for metals and VOCs and ICs similar to those described for Alternative GW-2. Alternatives GW-3A and GW-3B involve using different in-situ treatment reagents (a biological substrate for 3A and zero-valent iron for 3B), to treat VOCs. Because Alternatives GW-3A and GW-3B do not treat metal COCs, metals would be monitored under this alternative. Alternatives GW-3A and GW-3B are intended to reduce the required time to meet the groundwater RAOs, and, as a result, the length of groundwater monitoring and possibly the time required for the ICs. The ICs in Alternatives GW-3A and GW-3B would be the same as the ICs in Alternative GW-2.

4.1.7.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs for Alternative GW-3A and GW-3B that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.7.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative GW-3A and GW-3B that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.7.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative GW-3A and GW-3B that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.8 Alternative GW-4A and GW-4B: In-Situ Treatment for VOCs and Metals, Groundwater Monitoring, and Institutional Controls

Alternatives GW-4A and GW-4B consist of in-situ treatment of the contaminant plumes for both VOCs and metals in addition to groundwater monitoring and ICs similar to Alternative GW-2. Alternatives GW-4A and GW-4B involve using different in-situ treatment reagents. Alternative GW-4A would use a slow-release substrate designed to promote anaerobic bioremediation to degrade chlorinated COCs to nontoxic compounds. Alternative GW-4B would use a metal-organo-sulfur compound to treat for metals. These alternatives were selected to reduce the required time to meet the groundwater RAOs, and as a result, the length of groundwater monitoring and possibly the time required for ICs. Groundwater monitoring for the ROCs would be used to confirm site conditions and ensure that, over time, the potential exposure pathway remains incomplete.

4.1.8.1 Potential Federal and State Chemical-specific ARARs

There are no additional federal or state chemical-specific ARARs for Alternative GW-3A and GW-3B that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.8.2 Potential Federal and State Location-specific ARARs

There are no additional federal or state location-specific ARARs for Alternative GW-3A and GW-3B that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.8.3 Potential Federal and State Action-specific ARARs

There are no additional federal or state action-specific ARARs for Alternative GW-3A and GW-3B that are not already referenced in the Revised FS for Parcel D (SulTech, 2007).

4.1.9 Alternative R-2: Survey, Decontamination, Excavation, Disposal, and Release

Alternative R-2 consists of decontamination of radiologically-impacted buildings and dismantlement if necessary. Surveys of buildings, soils of former building sites and outdoor areas, trenches resulting from sewer and storm line removal, and soils of remediated storm drains and sanitary sewers would be conducted to meet the RAOs. Excavation of soils to remove radioactive materials will be conducted to achieve unrestricted release at the Gun Mole Pier and the former NRDL Site on Mahan Street.

4.1.9.1 Potential Federal and State Chemical-specific ARARs

Potential federal and state chemical-specific ARARs for Alternative R-2 are presented in Tables C.2-1 and C.2-2, respectively.

4.1.9.2 Potential Federal and State Location-specific ARARs

Potential federal and state location-specific ARARs for Alternative R-2 are presented in Table C.3-1.

4.1.9.3 Potential Federal and State Action-specific ARARs

Potential federal and state action-specific ARARs for Alternative R-2 are presented in Table C.4-1.

5.0 REFERENCES

SulTech. 2007. *Revised Feasibility Study for Parcel D*. SulTech: 1230 Columbia Street, Suite 1000, San Diego, CA. July 6.

U.S. Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA; Interim Final*. U.S. Environmental Protection Agency Guidance. EPA 540-G-89-004. October.

TABLES

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901-6991[i]) [b]				
Defines RCRA hazardous waste. A solid waste is characterized as toxic, based on the TCLP, if the waste exceeds the TCLP maximum concentrations.	Waste	22 CCR §§66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100	Applicable	Applicable for determining whether waste is hazardous and already identified in the Revised FS for Parcel D.
Toxic Substances control Act (15 U.S.C., ch. 53, §§ 2601-2692) [b]				
Regulates storage and disposal of PCB remediation waste. There are three options: (a) self-implementing on-site cleanup and disposal; (b) performance-based disposal using existing approved disposal technologies; and (c) risk-based disposal.	Soils, debris, sludge, or dredged materials contaminated with PCBs at concentrations greater than 50 ppm	40 CFR §761.61(c)	Not an ARAR	This FS is for radioactive material, not PCBs.
Uranium Mill Tailings Radiation Control Act (42 U.S.C., Chapter 88, §§ 192.02, 192.12(a,b), 192.42) [b]				
Control of residual radioactive materials shall be designed to: Be effective for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years, and, Provide reasonable assurance that releases of ^{222}radon from residual radioactive material into the atmosphere will not: (1) Exceed an average release rate of 20 picocuries per square meter per second. This average shall apply over the entire surface of the	Inactive Uranium Processing site	40 CFR §192.02(a), (b)	Not an ARAR	Parcel D is not an inactive uranium processing site; hence this citation is not applicable. Since all radioactive materials will be remediated, it is highly unlikely the criteria for releases of ^{222}radon from residual radiological material into the atmosphere would be exceeded at Parcel D.

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials into the atmosphere. or, (2) Increase the annual average concentration of ^{222}radon in air at or above any location outside the disposal site by more than 0.5 picocurie per liter.				
Standards for cleanup of land and buildings contaminated with ^{226}radium, ^{228}radium, and thorium from inactive uranium processing sites. As a result of residual radioactive materials from any designated processing site: (a) The concentration of ^{226}radium in land averaged over any area of 100 square meters shall not exceed the background level by more than:	UMTRCA sites	40 CFR §§ 192.12(a), 192.32(b)(2) and 192.41	Not an ARAR	Not applicable because Parcel D is not an UMTRCA site. The surface and subsurface concentration of 5pCi/g is not applicable since there will only be an unrestricted land-use scenario.

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and (2) 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.				
In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Provisions applicable to ^{222}radon shall also apply to ^{220}radon.	UMTRCA sites	40 CFR §§ 192.12(b)(1) 192.41(b)	Not an ARAR	Not applicable because Parcel D is not an UMTRCA site. Since all radioactive materials will be remediated, the alternatives will not result in radioactive material with radioactive contamination that may produce this level of dose.
Concentration limits for cleanup of gamma radiation in buildings at inactive uranium processing sites designated for remedial action. In any occupied or habitable building, the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.	UMTRCA sites	40 CFR § 192.12(b)(2)	Not an ARAR	Not applicable because Parcel D is not an UMTRCA site. Since all radioactive materials will be remediated, the alternatives will not result in radioactive material with radioactive contamination that may produce this level of dose.
Dose Limits for Individual Members of the Public				
Requires that the TEDE to individual members of public not exceed 0.1 rem from licensed operation: construction, operation, and decommissioning of commercial reactors	Existing NRC-licensed radiologically contaminated site	10 C.F.R., § 20.1301(a)(1)	Not an ARAR	This regulation is not applicable because Parcel D is not an NRC-licensed radiologically contaminated site. This

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
and fuel cycle facilities; possession, use, processing, exporting, and certain aspects of transporting nuclear materials and waste; and siting, design, construction, operations, and closure of waste disposal sites.				regulation is not potentially relevant and appropriate since no radioactive materials will be left onsite in a waste disposal or otherwise regulated facility.
Radiological Criteria for License Termination				
A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in TEDE to an average member of the critical group that does not exceed 25 mrem/y, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to ALARA.	Existing NRC-licensed radiologically contaminated site	10 CFR § 20.1402	Relevant and appropriate	This ARAR is not applicable because Parcel D is not an NRC-licensed radiologically contaminated site. This ARAR is potentially relevant and appropriate for an unrestricted land-use scenario.
As a condition for license termination with restricted site use, the licensee must demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of 10 U.S.C. § 20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with the restricted conditions are ALARA.	Existing NRC-licensed radiologically contaminated site	10 CFR § 20.1403(a)	Not an ARAR	This requirement is not an ARAR because Parcel D is not an NRC-licensed radiologically contaminated site nor will radioactive materials be left on-site
As a condition for license termination with restricted site use, the licensee must make provisions for legally enforceable ICs that provide reasonable assurance that the TEDE from residual radioactivity distinguishable	Existing NRC-licensed radiologically contaminated site	10 CFR § 20.1403(b)	Not an ARAR	This requirement is not an ARAR because Parcel D is not an NRC-licensed radiologically contaminated site and will not have a restricted release since no

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
from background to the average member of the critical group will not exceed 25 mrem/y.				waste may be left on site.
Alternate criteria are allowed for license termination as long as assurance is provided that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 100-mrem/y limit of Subpart D, by submitting an analysis of possible sources of exposure; to the extent practical restrictions for on-site use are employed according to the provisions of § 20.1403 in minimizing exposures at the site; and doses are reduced to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal.	Existing NRC-licensed radiologically contaminated site	10 CFR, § 20.1404(a)(1), (2), and (3)	Not an ARAR	Not applicable because Parcel D is not an NCR-regulated site. This ARAR is not an ARAR since no ALARA analysis has been documented and the calculated dose is less than 25 mrem/y.
Provides a benchmark approach for setting cleanup levels for radionuclides as a supplement to 40 CFR § 192.	UMTRCA site	10 CFR § 40, Appendix A, Part I, Criterion 6(6)	Not an ARAR	Not applicable because Parcel D is not an UMTRCA site. Since all radioactive materials will be remediated, the alternatives will not result in radioactive material with radioactive contamination that may produce this level of dose.
Performance objectives for the land disposal of LLRW. Concentrations of radioactive material that may be released into the general environment must not result in an annual	Existing NRC-licensed LLRW disposal site	10 CFR § 61.41	Not an ARAR	Parcel D is not an NRC-licensed radiologically contaminated site. This ARAR is not an ARAR since no radioactive waste will

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs
FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
dose exceeding 25 mrem to the body or any organ of a member of the general public.				remain on site.
Air				
Clean Air Act (42 U.S.C., ch 85, §§ 7401-7671				
NAAQS: Primary and secondary standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead).	Contamination of air affecting public health and welfare	40 CFR § 50.4-50.12	Not an ARAR	Not enforceable and therefore not an ARAR.
Resource Conservation and Recovery Act Emissions Requirements (42 U.S.C., ch. 82, §§ 6901–6991[i])				
Air emission standards for process vents or equipment leaks.	Air emission standards for process vents or equipment leaks.	CCR tit. 22 § 66264.1030-66264.1034, excluding 1030(c), 1033(j), 1034(c)(2), 1034(d)(2) CCR tit. 22 § 66264.1050-66264.1063, excluding 10509c), (d), 1057(g)(2), 1060,163(d)93)	Not an ARAR	Not an ARAR since this regulation does not cover radiological constituents of concern.
NESHAPs under CAA that Apply to Radionuclides				
Emissions of radionuclides into the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of	Facility owned or operated by the Department of Energy that emits any radionuclide other than ^{222}radon and ^{220}radon into the air	40 CFR § 61.92	Relevant and appropriate	Not applicable because Parcel D is not a Department of Energy site but may be relevant and appropriate if there is the potential for airborne emissions

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
10 mrem/y.				of radionuclides other than radon. Only an ARAR until cleanup action is completed. Not an ARAR for residual contamination after cleanup.
Emissions of radionuclides, including iodine, into the ambient air from a facility regulated under this subpart shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/y. Emissions of iodine into the ambient air from a facility regulated under this subpart shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 3 mrem/y.	Facilities owned or operated by any federal agency other than the Department of Energy and not licensed by the NRC	40 CFR § 61 Subpart I § 61.102	Applicable	The requirements are applicable since fugitive dust may be generated during implementation of remedial action at Parcel D. The exposure to the public due to remedial action operations at Parcel D is not likely to exceed 10 mrem/y because of the following reasons: 1) The concentrations of any radionuclide in dust are relatively low as previously measured in air samples, and 2) The concentration of any radionuclide in dust will be reduced by use of engineering controls such as wetting of soils.
Surface Water				
Concentration limits for liquid effluent from facilities that extract and process uranium, radium, and vanadium ores: ^{226}Radium (dissolved) 10.0 pCi/L maximum per day	Discharges to surface water from certain kinds of mines and mills	40 CFR, § 440, Subpart C, §§ 440.30–440.35	Not an ARAR	Not an ARAR because discharge to surface water is not a proposed action and Parcel D is not a mine or mill.

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs
FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
3.0 pCi/L average 30 days ^{226}Radium (total) 30.0 p/Ci/L maximum per day 10.0 p/Ci/L average 30 days Uranium 4.0 mg/L maximum per day 2.0 mg/L average 30 days				
Uranium Mill Tailings Radiation Control Act (42 U.S.C., Chapter 88, §§ 192.02, 192.12(a,b), 192.42)[b]				
Control of residual radioactive materials shall be designed to: Be effective for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years, and, Provide reasonable assurance that releases of ^{222}radon from residual radioactive material to the atmosphere will not: (1) Exceed an average release rate of 20 picocuries per square meter per second. This average shall apply over the entire surface of the disposal site and over at least a 1-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however,	Inactive uranium processing sites (radioactivity above 5 pCi/g)	40 CFR § 192.02(a),(b)	Not an ARAR	Not applicable since Parcel D was not a uranium processing site. Potentially relevant and appropriate for sites where there is a potential for residual radium, uranium or thorium to release ^{220}radon or ^{222}radon. There is residual radium but not at the levels to meet the requirement.

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
applies only to emissions from residual radioactive materials to the atmosphere. Or, (2) Increase the annual average concentration of ^{222}radon in air at or above any location outside the disposal site by more than 0.5 pCi/L.				

TABLE C.2-1

POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Notes:

[a] Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables.

[b] Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the statutes or policies in their entirety as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of the specific citations are considered potential ARARs.

Abbreviations and Acronyms:

§ – section
ALARA – as low as reasonable achievable
ARAR – applicable or relevant and appropriate requirement
CAA – Clean Air Act
CCR – California Code of Regulations
CFR – Code of Federal Regulations
ch – chapter
cm – centimeter
DON – Department of the Navy
FS – Feasibility Study
LLRW – low-level radioactive waste
mg/L – milligram per liter
mrem/y – millirem per year
NAAQS – National Ambient Air Quality Standards
NESHAPS – National Emissions Standards for Hazardous Air Pollutants
NRC – Nuclear Regulatory Commission
PCB – polychlorinated biphenyl
pCi/g – picocurie per gram
pCi/L – picocurie per liter
ppm – part per million
RCRA – Resource Conservation and Recovery Act
TCLP – Toxicity Characteristic Leaching Procedure
TEDE – total effective dose equivalent
tit. – title
UMTRCA – Uranium Mill Tailings Radiation Control Act
U.S.C. – United States Code
WL – working level

TABLE C.2-2

POTENTIAL STATE CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
State Water Resources Control Board and Regional Water Quality Control Boards [b]				
Requires the operator of a landfill to ensure that the concentration of methane gas migrating from a landfill does not exceed 5 percent by volume in air at the facility property boundary and that the concentration of methane gas does not exceed 1.25 percent by volume in air in any on-site structures during closure and post-closure of the landfill.	Landfill	CCR tit. 27, § 20921(a)(1) and (2)	Not an ARAR	There is no landfill at Parcel D.
The average concentration of beta particle activity and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/y.	Not applicable	22 CCR Section 64443(a)	Not an ARAR	Not more stringent than federal MCLs at 40 CFR § 141.66.
Compliance with this requirement is assumed if the average concentration of gross beta particle activity is less than 50 pCi/L and if the average concentration of tritium and strontium-90 are less than those listed on Table 4 of 22 CCR Section 64443(b).	Not applicable	22 CCR Section 64443(b)	Not an ARAR	Not more stringent than federal MCLs at 40 CFR § 141.66.
If the gross beta particle activity exceeds 50 pCi/L, an analysis of the sample shall be performed to identify the major radioactive constituent present and the appropriate organ and total body doses shall be calculated.	Not applicable	22 CCR Section 64443(c)	Not an ARAR	Not more stringent than federal MCLs at 40 CFR § 41.66.

TABLE C.2-2

POTENTIAL STATE CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
Radionuclide concentrations for waters designated as domestic or municipal supply. • Combined radium-226 and -228 – 5 pCi/L • Gross alpha particle activity (including radium-226, but excluding radon and uranium) – 15 pCi/L • Tritium – 20,000 pCi/L • Strontium-90 – 8 pCi/L • Gross beta particle activity – 50 pCi/L • Uranium – 20 pCi/L				
Cal/EPA Department of Toxic Substances Control				
Defines "non-RCRA hazardous waste"	Waste	CCR tit. 22 § 66261.22(a)(3) and (4), § 66261.24(a)(2)-(a)(8), § 66261.101, § 66261.3(a)(2)(C), and § 66261.3(a)(2)(F)	Applicable	Applicable for determining whether a waste is or is not RCRA-hazardous waste. These requirements are already identified in the Revised FS for Parcel D (SulTech, 2007).
Establishes concentration limits for cleanup actions, including groundwater, surface water, and the unsaturated zones for other than hazardous waste at background. Allows a higher cleanup limit (but not to exceed MCLs) if background is not technically or economically achievable.		CCR tit.27 §§ 20380(a); 20400 (a), (d), (e), and (g) ; and 20405	Not an ARAR	Not more stringent than federal regulations at CCR tit. 22 § 66264.94.

TABLE C.2-2

POTENTIAL STATE CHEMICAL-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
Establishes concentration limits for cleanup action, including groundwater, surface water, and the unsaturated zones for other than hazardous waste at background. Allows a higher cleanup limit (but not to exceed MCLs) if background is not technically or economically achievable.		CCR tit.27 § 120400	Not an ARAR	Not more stringent than federal regulations at CCR tit. 22 § 66264.94.
Definitions of designated waste, nonhazardous waste, and inert waste.		CCR tit. 27 §§ 20210, 20220, and 20230	Applicable	Potential ARARs for classifying waste and determining ARAR status of other requirements. These requirements are already identified in the Revised FS for Parcel D (SulTech, 2007).
California Department of Health Services [b]				
Standards for protection from radiation. This regulation incorporates 10 CFR §§ 20.1001 – 20.2402 and Appendices A – G by reference.		CCR tit. 17 § 30253	Not an ARAR	These state regulations incorporate portions of the federal ARARs and are not more stringent than the federal ARARs.

Notes:

[a] Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables.

[b] Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the statutes or policies in their entirety as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of the specific citations are considered potential ARARs.

Abbreviations and Acronyms:

§ – section
ARAR – applicable or relevant and appropriate requirement
Cal/EPA – California Environmental Protection Agency
CCR – California Code of Regulations
CFR – Code of Federal Regulations
DON – Department of the Navy
FS – Feasibility Study
MCL – maximum contaminant level
pCi/L – picocurie per liter
RCRA – Resource Conservation and Recovery Act
tit. – title

TABLE C.3-1

POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Pre-requisite	Citation[a]	ARAR Determination	Comments
National Historic Preservation Act of 1966, as Amended (Title 16 U.S.C., Sections 470-470x-6)[b]				
Action to preserve historic properties; planning of action to minimize harm to properties listed on or eligible for listing on the national Register of Historic Places.	Properties included in or eligible for the national Register of Historic Places	16 U.S.C., Sections 470-470x-6, 36 CFR § 800, and 40 CFR § 6.301(b)	Applicable	The DON has determined that the Gun Mole Pier Gantry Crane is eligible for inclusion on the National Register of Historic Places. The DON is in compliance with this ARAR because none of the remedial alternatives evaluated in this Revised Feasibility Study Addendum include activities that will have an impact on the building structure.
CZMA (Title 16 U.S.C., Sections 1451-1464)[b]				
Within coastal zone.	Activities conducted in a manner consistent with approved state management programs	16 U.S.C., Section 1456(c) and 15 CFR § 930	Relevant and appropriate	The CZMA excludes federal lands from the coastal zone; however, since portions of Parcel D are within the coastal zone, the DON has determined that it is relevant and appropriate.
State Location-Specific Applicable or Relevant and Appropriate Requirements				
McAteer-Petris Act (California Government Code §§ 66600 through 66661)[b]				
Reduce fill and disposal of dredged material in San Francisco Bay, maintain marshes and mudflats to the fullest extent possible to conserve wildlife, abate pollution, and protect the beneficial uses of the Bay.	Activities affecting San Francisco Bay and 100 feet landward of the shoreline	San Francisco Bay Plan at CCR title 14 §§ 10110 through 11990	Relevant and appropriate	The San Francisco Bay Plan is an approved state coastal zone management program, and the DON will continue to conduct its response actions in accordance with the goals of the San Francisco Bay Plan.

TABLE C.3-1

POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

Requirement	Pre-requisite	Citation[a]	ARAR Determination	Comments
Reduce fill and disposal of dredged material in San Francisco Bay.	Activities affecting San Francisco Bay and 100 feet landward of the shoreline	California Government Code §§ 66600 – 66661.	Relevant and appropriate	The San Francisco Bay Plan is an approved state coastal zone management program, and the DON will continue to conduct its response actions in accordance with the goals of the San Francisco Bay Plan.

Notes:

[a] Only the substantive provisions of the requirements cited in this table are potential ARARs.

[b] Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the statutes or policies in their entirety as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of the specific citations are considered potential ARARs.

Abbreviations and Acronyms:

§ – section
ARAR – applicable or relevant and appropriate requirement
CCR – California Code of Regulations
CFR – Code of Federal Regulations
CZMA – Coastal Zone Management Act
DON – Department of the Navy
U.S.C. – United States Code

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[i])							
On-site waste generation	Person who generates waste shall determine if that waste is a hazardous waste.	Generator of waste.	CCR tit. 22, § 66262.10(a), 66262.11				Not an ARAR since Parcel D radiological waste has been determined not to be RCRA hazardous waste.
	Requirements for analyzing on-site waste for determining whether waste is hazardous.	Generator of waste	CCR tit. 22 § 66264.13(a) and (b)				Not an ARAR since Parcel D radiological waste has been determined not to be RCRA hazardous waste.
Hazardous waste accumulation	On-site hazardous waste accumulation is allowed for up to 90 days as long as the waste is stored in containers in accordance with § 66262.171-178 or in tanks, on drip pads, inside buildings, and is labeled and dated, etc.	Accumulation of hazardous waste	CCR tit. 22 § 66262.34				Not an ARAR since Parcel D radiological waste has been determined not to be RCRA hazardous waste.

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Site closure	Minimize the need for further maintenance controls and minimize or eliminate, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated rainfall or runoff, or waste decomposition products to groundwater or surface water or to the atmosphere.	Hazardous waste management facility	CCR tit. 22 § 66264.111(a) and (b)				Not an ARAR since Parcel D radiological waste has been determined not to be RCRA hazardous waste.
Container storage	Storage containers of RCRA hazardous waste must be maintained in good condition, compatible with hazardous waste to be stored, and closed during storage except to add or remove waste.	Storage of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere, in a container	CCR tit. 22 § 66264.171, 172, and 173				Not an ARAR since Parcel D radiological waste has been determined not to be RCRA hazardous waste.
	Inspect storage container storage areas weekly for deterioration.		CCR tit. 22 § 66264.174				Not an ARAR since Parcel D radiological waste has been determined to not be RCRA hazardous waste.

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	Place storage containers on a sloped, free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaded waste in a timely manner to prevent overflow of the containment system.		CCR tit. 22 § 66264.175(a) and (b)				Not an ARAR since Parcel D radiological waste has been determined to not be RCRA hazardous waste.
Disposal of radioactive material	Performance objectives for the land disposal of LLRW. Concentrations of radioactive material that may be released to the general environment must not result in an annual dose exceeding 25 mrem to the body or any organ of a member of the general public.	NRC-licensed LLRW disposal site	10 CFR § 61.41				Not applicable since Parcel D is not an NRC- regulated site. Not potentially relevant and appropriate because radioactive waste will not be disposed of on site.
	Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active ICs over the disposal site are removed.	Not applicable	10 CFR § 61.42				Not applicable since Parcel D is not an NRC- regulated site. Not potentially relevant and appropriate because radioactive waste will not be disposed of on site.

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	Performance objectives for the land disposal of LLRW. Concentrations of radioactive material that may be released into the general environment must not result in an annual dose exceeding 25 mrem to the body or any organ of a member of the general public.	NRC-licensed LLRW disposal site	10 CFR § 61.41				Not applicable since Parcel D is not an NRC- regulated site. Not potentially relevant and appropriate because radioactive waste will not be disposed of on site.
	Discharges to surface water from certain kinds of mines and mills	Every reasonable effort shall be made to maintain radiation exposures ALARA.	10 CFR § 61.43				Not applicable since Parcel D is not an NRC-regulated site or potentially relevant and appropriate since no releases of radioactive material will be made to surface water.
	The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.	Not applicable	10 CFR § 61.44				Not applicable since Parcel D is not an NRC-regulated site. Not potentially relevant and appropriate because radioactive waste will not be disposed of on site.

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	A licensee shall dispose of licensed material only by: transfer to an authorized recipient, by decay in storage; or by release in effluents within the limits in § 20.1301; or as authorized under §§ 20.2002, 20.2003, 20.2004, or 20.2005.	NRC-licensed waste	10 CFR § 20.2001(a)				Not applicable since Parcel D is not an NRC-regulated site. Not potentially relevant and appropriate because radioactive waste will not be disposed of on site.

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	A licensee may discharge licensed radioactive waste material into sanitary sewerage if each of the following conditions is satisfied: the material is readily soluble in water; and the quantity that the licensee releases into the sewer in 1 month divided by the average monthly volume of water released does not exceed the concentration listed in Table 3 of Appendix B to 10 CFR § 20; and if more than one radionuclide is released, the licensee shall determine the fraction of the limit in Table 3 of Appendix B to 10 CFR § 20 represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in Table 3 of Appendix B to 10 CFR § 20; and the sum of the fractions for each radionuclide required by paragraph (a)(3)(i) of this section does not exceed unity; and the total quantity of licensed and other		10 CFR § 20.2003				Not applicable since Parcel D is not an NRC- regulated site. Not potentially relevant and appropriate because radioactive waste will not be discharged to sanitary sewer.

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	radioactive material that the licensee releases into the sanitary sewerage system in a year and does not exceed 5 Ci (185 GBq) of hydrogen-3, 1 Ci (37 GBq) of carbon-14, and 1 Ci (37 GBq) of all other radioactive materials combined.						

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

The alternatives for this feasibility study are: S-1–No Action; S-2–Institutional Controls and Maintained Landscaping; S-3–Excavation, Disposal, Maintained Landscaping, and Institutional Controls; S-4–Covers and Institutional Controls; S-5–Excavation, Disposal, Covers, and Institutional Controls; R-1-No Action; and R-2–Survey, Decontamination, Disposal, Excavation, and Release.

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	A licensee may treat or dispose of licensed material by incineration only: as authorized by paragraph (b) of this section; or if the material is in a form and concentration specified in § 20.2005. Waste oils that have been radioactively contaminated in the course of the operation or maintenance of a nuclear power reactor may be incinerated on the site where generated provided that the total radioactive effluents from the facility, including the effluents from such incineration, conform to the requirements of Appendix I to § 50 of this chapter and the effluent release limits contained in applicable license conditions other than effluent limits specifically related to incineration of waste oil. Solid residues produced in the process of incinerating waste oils must be disposed of as provided by § 20.2001.		10 CFR § 20.2004(a)				Not applicable since Parcel D is not an NRC-regulated site. Not potentially relevant and appropriate for sites containing radioactive waste since the waste will not be incinerated.

Abbreviations and Acronyns:

§ – section

A – applicable

TABLE C.4-1

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs FOR HUNTERS POINT SHIPYARD PARCEL D

ALARA – as low as reasonably achievable
ARAR – applicable or relevant and appropriate requirement
CCR – California Code of Regulations
CFR – Code of Federal Regulations
Ci – curie
GBq – gigabecquerel
IC – institutional control
LLRW – low-level radioactive waste
mrem – millirem
NRC – Nuclear Regulatory Commission
RA – relevant and appropriate
RCRA – Resource Conservation and Recovery Act
TBC – to be considered
tit. – title
U.S.C. – United States Code

APPENDIX D

RESPONSE TO COMMENTS

RESPONSE TO COMMENTS FOR
DRAFT FINAL RADIOLOGICAL ADDENDUM TO THE FEASIBILITY STUDY FOR PARCEL D,
HUNTERS POING SHIPYARD, SAN FRANCISCO, CALIFORINA
(DATED: JANUARY 18, 2008)
DCN: ECSD-2201-0006-0078

Reviewed by Thomas P. Lanphar, Senior Hazardous Substance Scientist
Office Military Facilities, Department of Toxic Substances Control, Comments Dated: February 15, 2008

GENERAL COMMENTS	RESPONSE
Comment 1. Response to Comment #2 and #3. The document states that the surface scans and sampling would be performed at the Gun Mole Pier and the former NRDL site on Mahan Street. Soil excavations would be performed to completely remove radiological contamination. Please provide justification or data for the assumption that the contamination at Gun Mole pier is expected to be within the top 12 inches of soil beneath the asphalt cover. Please justify this with either some theoretical modeling or the site boring data. As identified in the historical radiological assessment document cesium, radium, plutonium and strontium are radionuclides of concern in the Gun Mole Pier and these have different soil migration rates. And therefore it is possible that some radiological material has migrated below the depth detectable by the surface scans or surface samples only. Please clarify the steps that will be involved in complete characterization of this land area for the health and safety of the public.	**Response 1.** The Navy does not have historical information regarding site radiological conditions below the surface of the asphalt at the Gun Mole Pier, and does not intend to do site borings for the purpose of this Radiological Addendum. The assumption that contamination at the Gun Mole pier is expected to be within the top 12 inches of soil beneath the asphalt is based on a review of historic photographs and engineering drawings which yield insight into construction practices employed at the time the pier was built. Additionally, research conducted in support of the Historical Radiological Assessment and ongoing radiological investigations support that assumption. Given the potential mechanisms of release, the Navy believes that it is reasonable to assume that contamination is limited to the top 12 inches of soil beneath the asphalt. Planning documents for the site-specific radiological investigation will allow for the delineation and assessment of potential radiological contamination below the asphalt surface. The asphalt surface will be removed to provide for adequate investigation of the original surface used by NRDL. A surface scan will determine if contamination has migrated through the asphalt and surface soil. The type and extent of any contamination will be fully assessed after all results have

	been received and reviewed.
Comment 2. Response to Comment #10. CDPH does not agree with the industrial and recreational exposure scenario used in RESRAD modeling of the chosen derived concentration guideline level (DCGL) for the Parcel D land areas. CDPH also does not agree with the values used for ingestion rate and the inhalation rate for calculation of annual radiation dose to the public. Please use the default ingestion rates and inhalation rates for an occupancy set to 24 hours 7 days a week.	**Response 2.** Comment noted. As previously discussed in the response to comments, once a radiologically-impacted site has been surveyed and considered acceptable for unrestricted release, the Navy will model the residual radioactivity using actual survey data in the appropriate RESRAD or RESRAD-BUILD model to determine residual dose and/or risk as appropriate. The default residential farmer scenario will be used with the actual surface area of each survey unit.
SPECIFIC COMMENTS	**RESPONSE**
Comment 1. Response to Comment #21. The Navy's justification for using .028 pico Curie/g for Cs-137, .647 pico Curie/g for Pu239, 0.25 pico Curie/g for Ra-226, and .0827 pico Curie/g for Sr-90 in the RESRAD dose evaluation for the above site is the sum unity fraction rule. Please confirm that for the land areas which have multiple ROCs the action levels would be defined by the sum unity fraction rule.	**Response 1.** The Navy does not have the data to support the use of the sum unity fraction rule, therefore the Navy does not plan to have action levels defined by the sum of fraction unity rule for land areas that have multiple ROCs. For land areas that have multiple ROCs, each ROC will be cleaned up to the appropriate DCGL. The unity rule will be used to determine input parameters for dose and risk modeling, and will be based on the results of the Final Status Surveys.